

Programme's After Market Services NHD-4 Series Transceivers

Disassembly & Troubleshooting

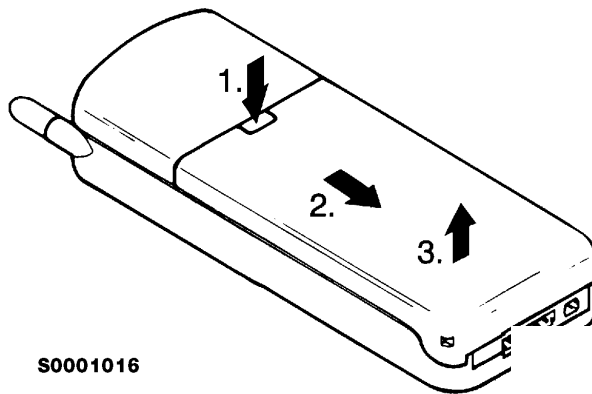
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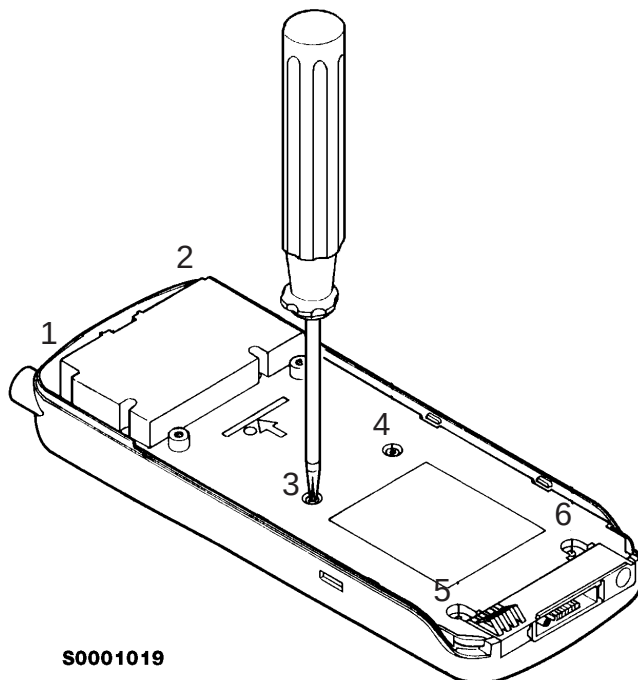
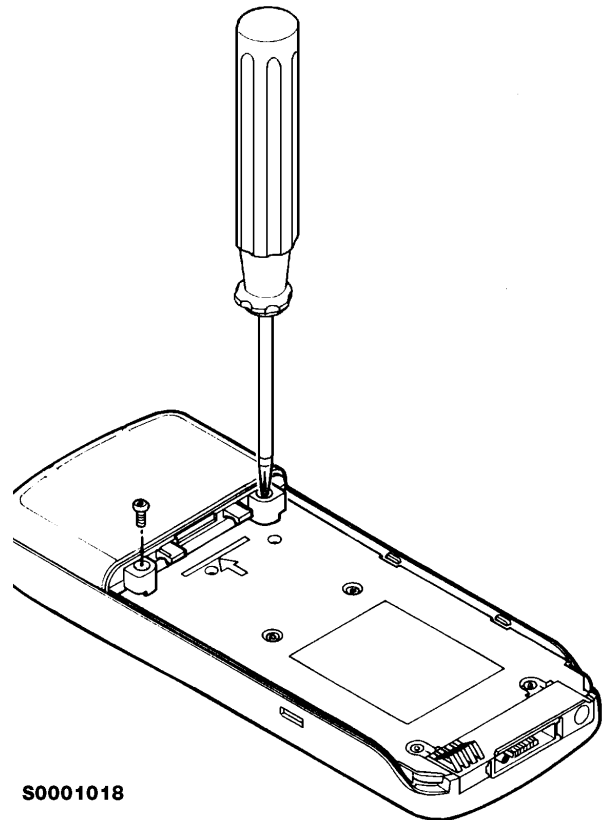
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Disassembly Instructions

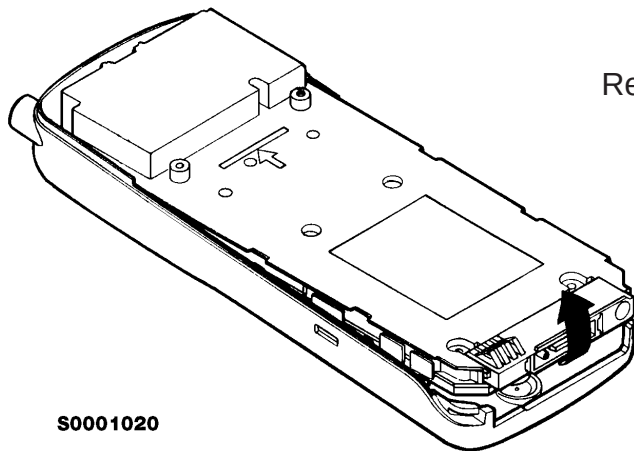


Remove the battery.

Now remove the cover screws and move the cover to the side by lifting it.

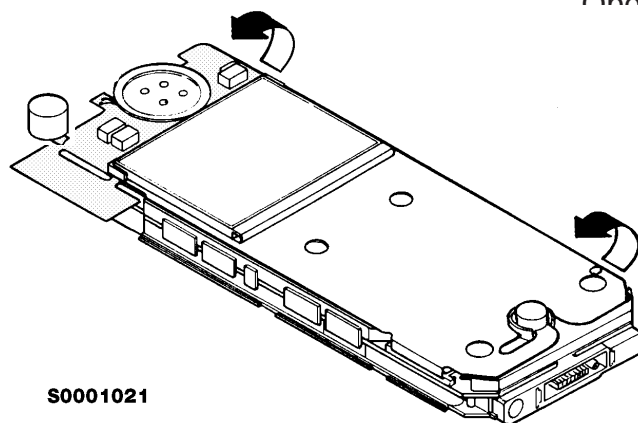


Then remove six chassis screws.



S0001020

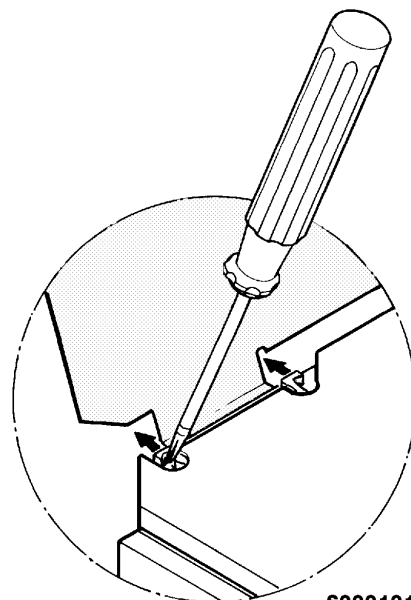
Remove the chassis by lifting.



S0001021

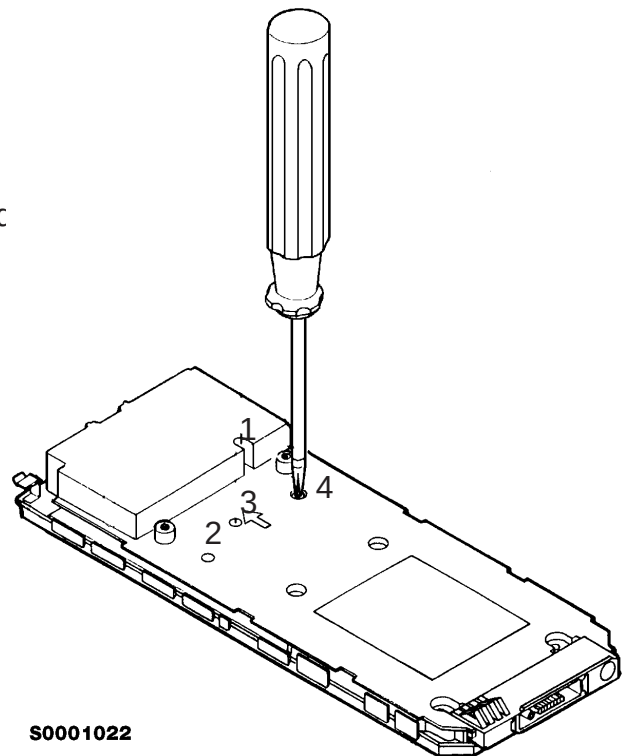
Turn around the chassis and open the display module a little.

Open the display module connector pressing both sides of connector slide off the display module.



S0001013

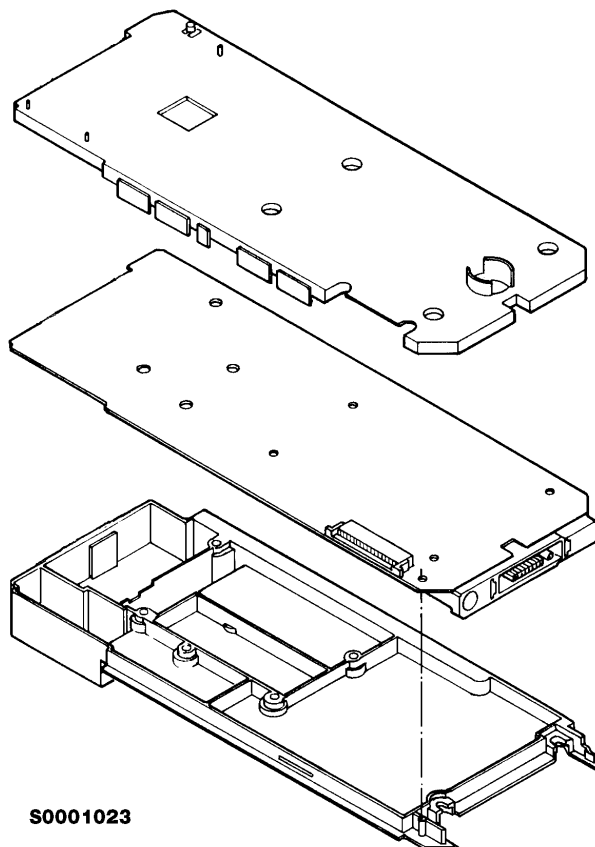
Turn chassis again and
four chassis screws.



S0001022

Remove the plastic shield and
throw it away (it is disposable).

Now you can separate the sys-
tem module from the bottom
shield by lifting it away.



S0001023

Baseband Troubleshooting

Overview

Baseband oriented failures are usually found out during Flash updating of the phone, the phone should be started to minimum mode and current consumption measured. If current consumption is within acceptable limits and MBUS registration is OK, flash is programmed. If flash programming fails, service software can be used to activate MCU self tests. During the MCU self tests all the major components of the baseband are tested. Every test returns number of the test and result (OK / failed).

If phone can be flashed and all self tests performed, the baseband is mainly OK.

In case of current consumption/MBUS registration failure, the phone must be taken to more specific measurements of voltages, clocking signals and states of reset signals.

The flow diagrams give the overview of the blocks. The purpose is to proceed through the flow diagram so that, if answer is YES for the asked question, go straight to the next level, but if answer is NO, take the sub-branch.

Required servicing equipment:

- Service software
- Power supply (1.0 A)
- Digital multimeter
- Oscilloscope
- Modular cable
- RS232/MBUS adapter
- Soldering iron and related tools.

Current consumption failures in flash station

Current consumption can fail in three ways. Typical to all these failures is that phone can not be programmed or tested via MBUS. The most common failure is that phone takes normal current during startup and after a few seconds all circuits are powered down. The reason for this could be in power, clock or reset distribution of the phone. In cases where phone does not take current at all or phone takes all available current the reason could be defective PSL_+3V(N500) or bad soldering (short or open) around PSL_+3V(N500).

Phone takes all available current

If phone takes all available current, the problem can be caused by bad solder joints in PSL_+3V(N500), components around it and bottom connector(X701).

Phone does not take current at all

If phone does not take current at all, check the following things:

- solder joints in PSL_+3V(N500)
- VBATT voltage should be available in pins 5 and 20 of PSL_+3V(N500), if connections of PSL_+3V(N500) are OK and VBATT in pins 5 and 20 are OK, change PSL_+3V(N500).

Current consumption OK during power-up, then fail

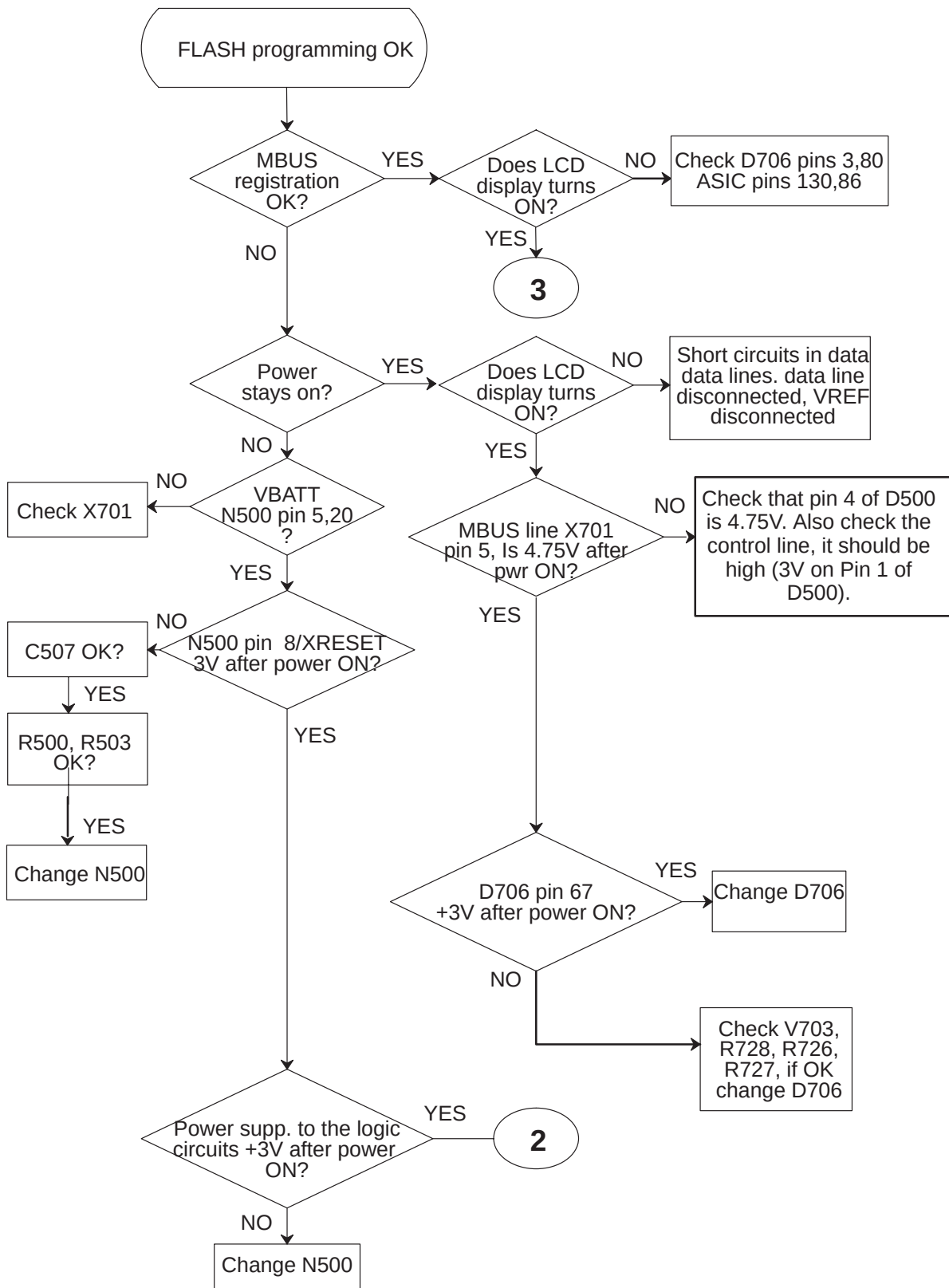
If the phone starts almost normally, but after few seconds all circuits are powered down, the power-down, could be caused by lack of watchdog signal from MCU(D706) to PSL_+3V(N500). There are three major things to be checked in this type of situation. First, check power distribution to all baseband-main components. Then check that clocks are delivered to CDRFI(N700), ASIC(D704), DSP(D705) and MCU(D706). If everything is OK, check RESET status of circuitry mentioned above.

Checking the baseband power distribution

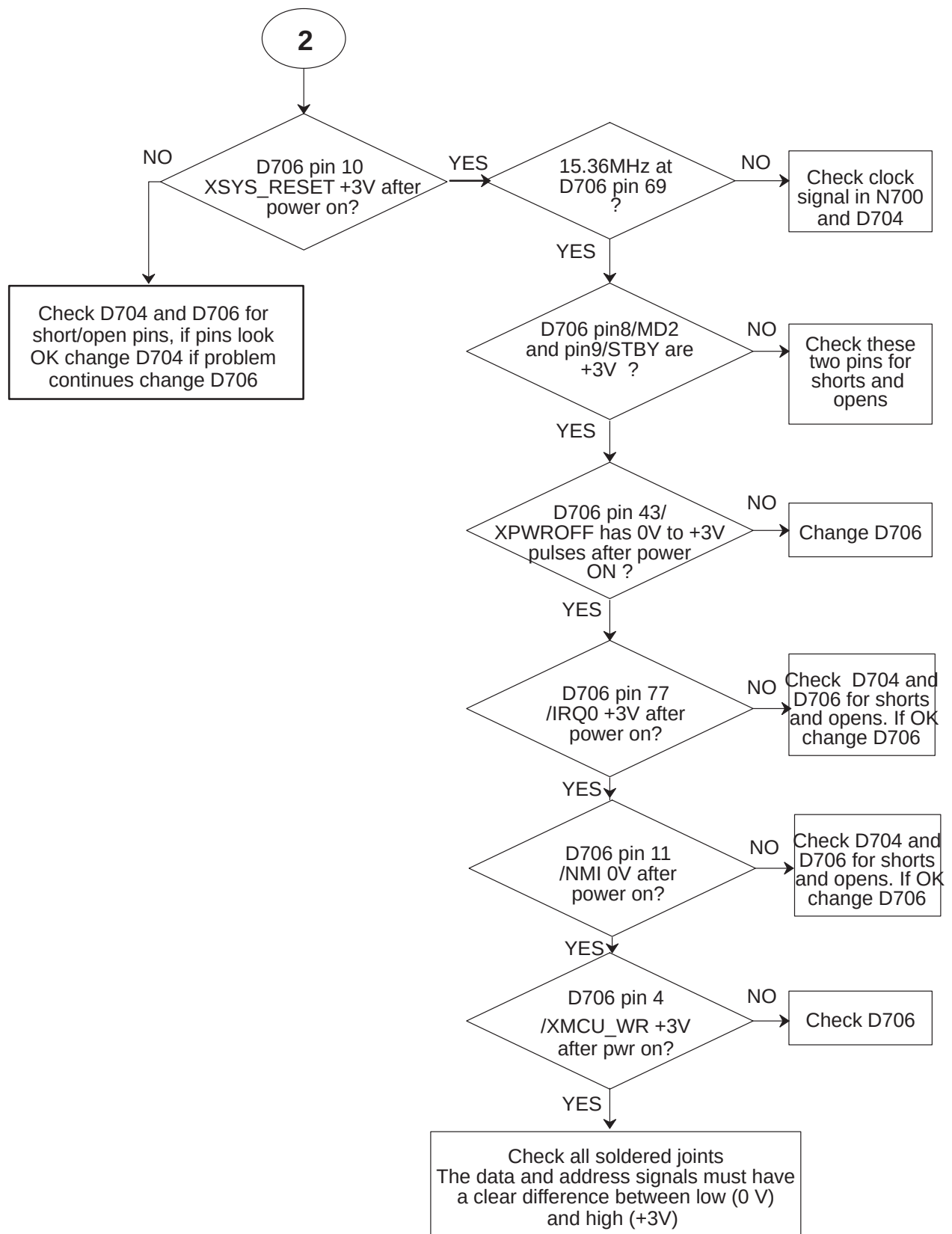
Before voltage measurements, power-down of PSL_+3V(N500) must be prevented. This is done by shorting the watch-dog timing capacitor C507 with a wire soldered from one end of the capacitor to the other.

1. Check PSL_+3V(N500) output voltages pins 4, 21, 16, 2, 24 and 1. Expected value is around 3.15V. Also, check voltage in pin 12 (DETIN) to be between 1.46V and 1.72V.
2. Check MCU(D706) supply voltage VL1(3.15V) on pins 5 and 42. Check VREF (3.15V) voltage on MCU(D706) pin 60. Check voltages of MCU(D706) related memory components: FLASH(D709) pins 30, 31 and 11; RAM(D700) pin 28; and EEPROM(D703) pin 7.
3. Check ASIC(D704) supply voltage VL1(3.15V) on pins 13, 22, 27, 44, 60, 65, 74, 88, 103, 109, 117, 132, 146, 151, 161, and 176.
4. Check DSP(D705) supply voltage VL2(3.15V) on pins 8, 11, 36, 39, 49, 64, 76, 87 and 90. VL2(3.15V) is also fed to DSP RAM (D707) to pin 11 and 33.
5. Check CDRFI(N700) supply voltage VL3(3.15V) on pins 32, 33, 60, 62, 2, 6, 8 and 19.
6. Check supply voltages of audio CODEC(N600). VA2(3.15V) is fed to pins 2 and 3. VL1(3.15V) is connected to pin 15.

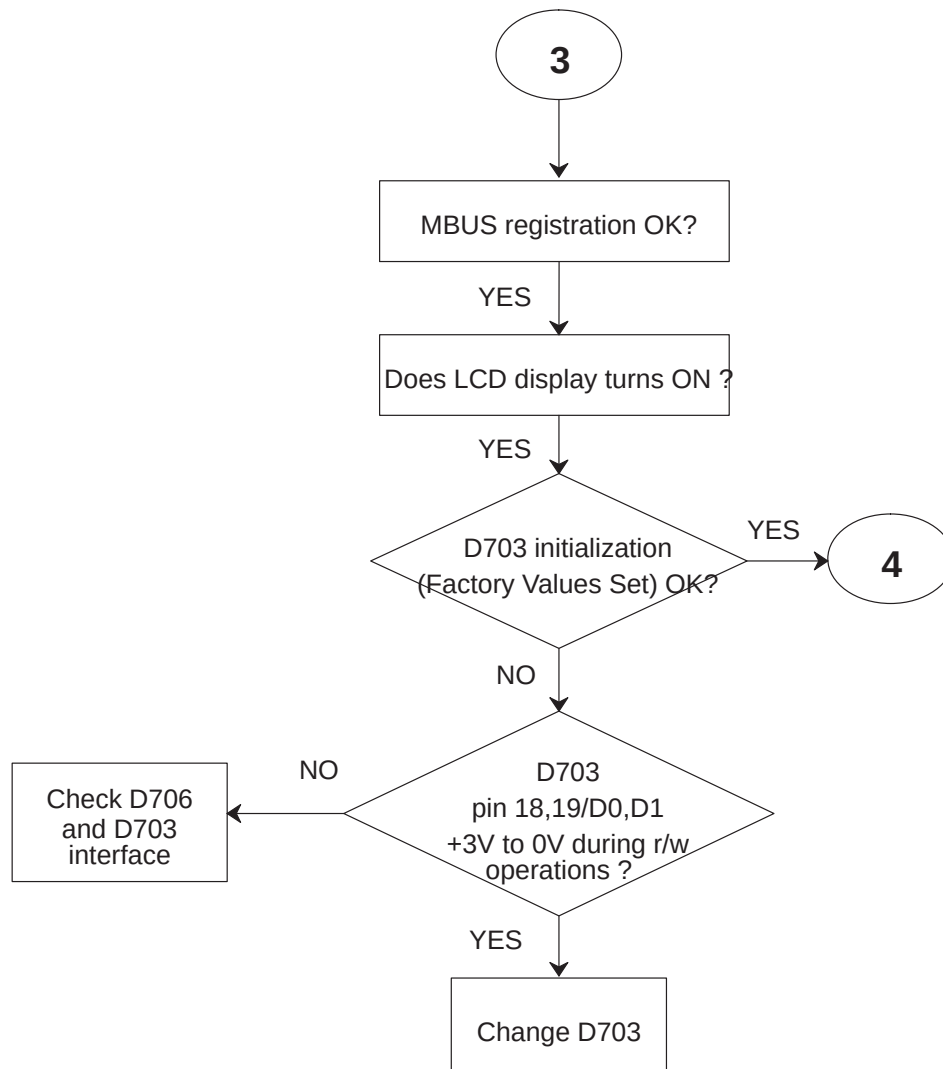
Troubleshooting Diagram; Flash Programming, part 1



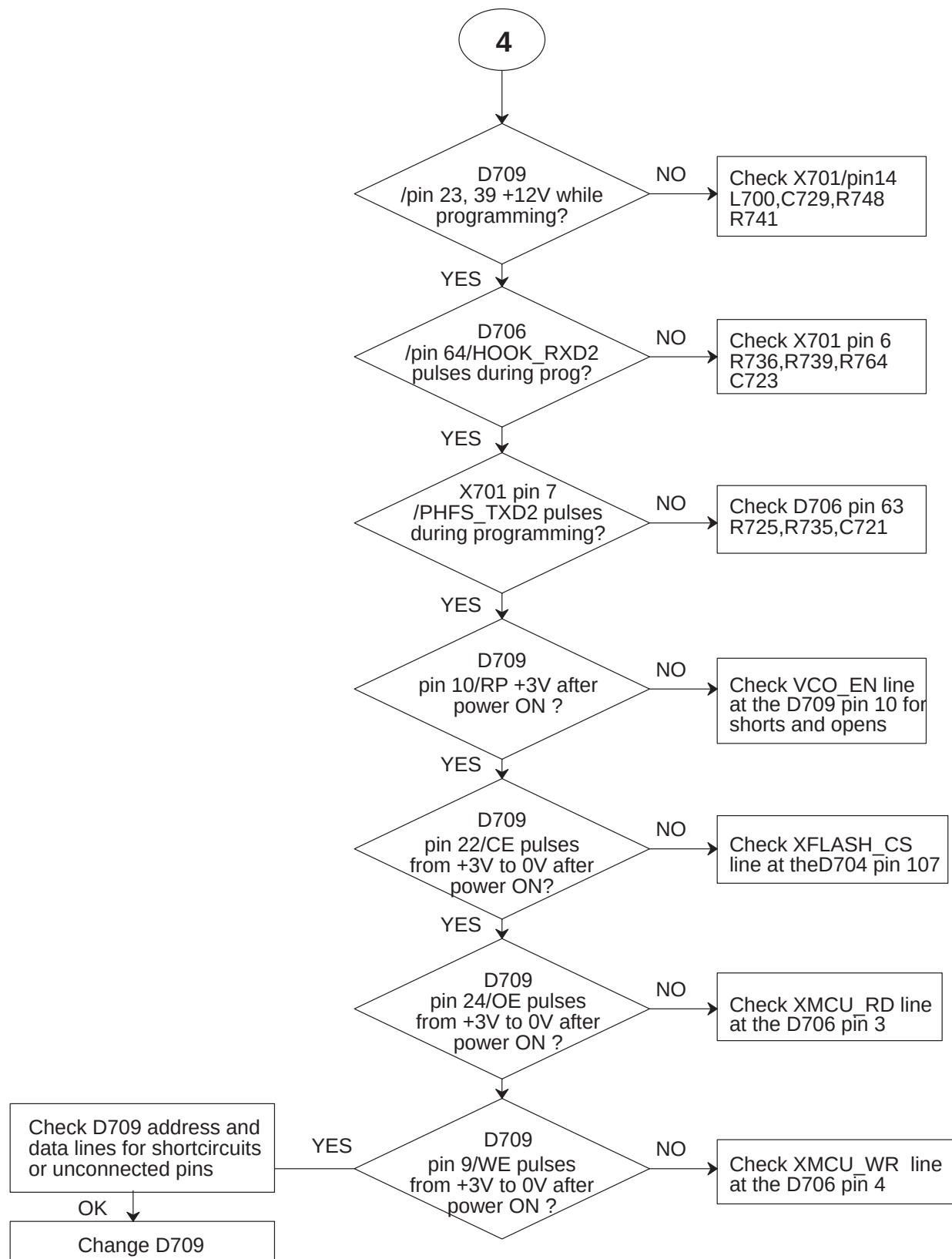
Troubleshooting Diagram; Flash Programming, part 2

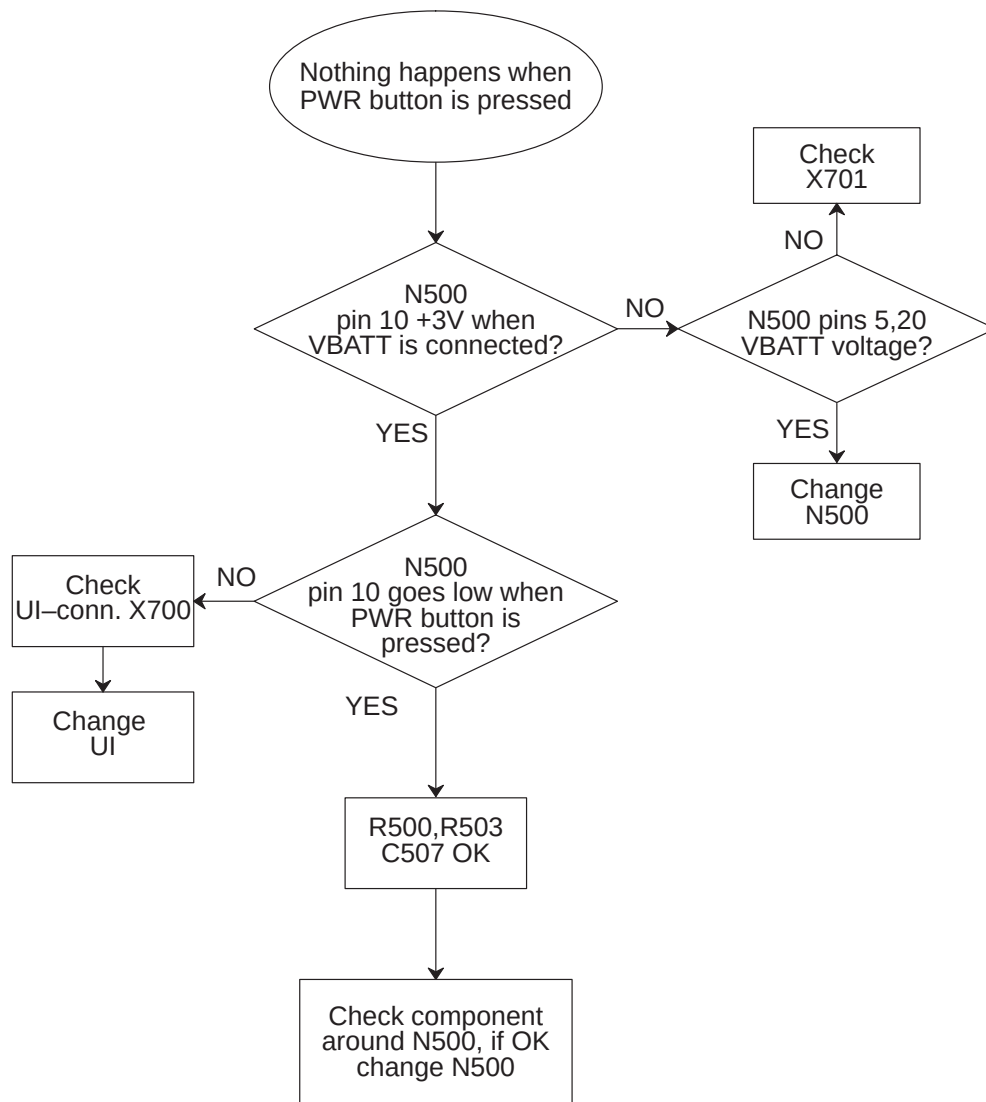


Troubleshooting Diagram; Flash Programming, part 3

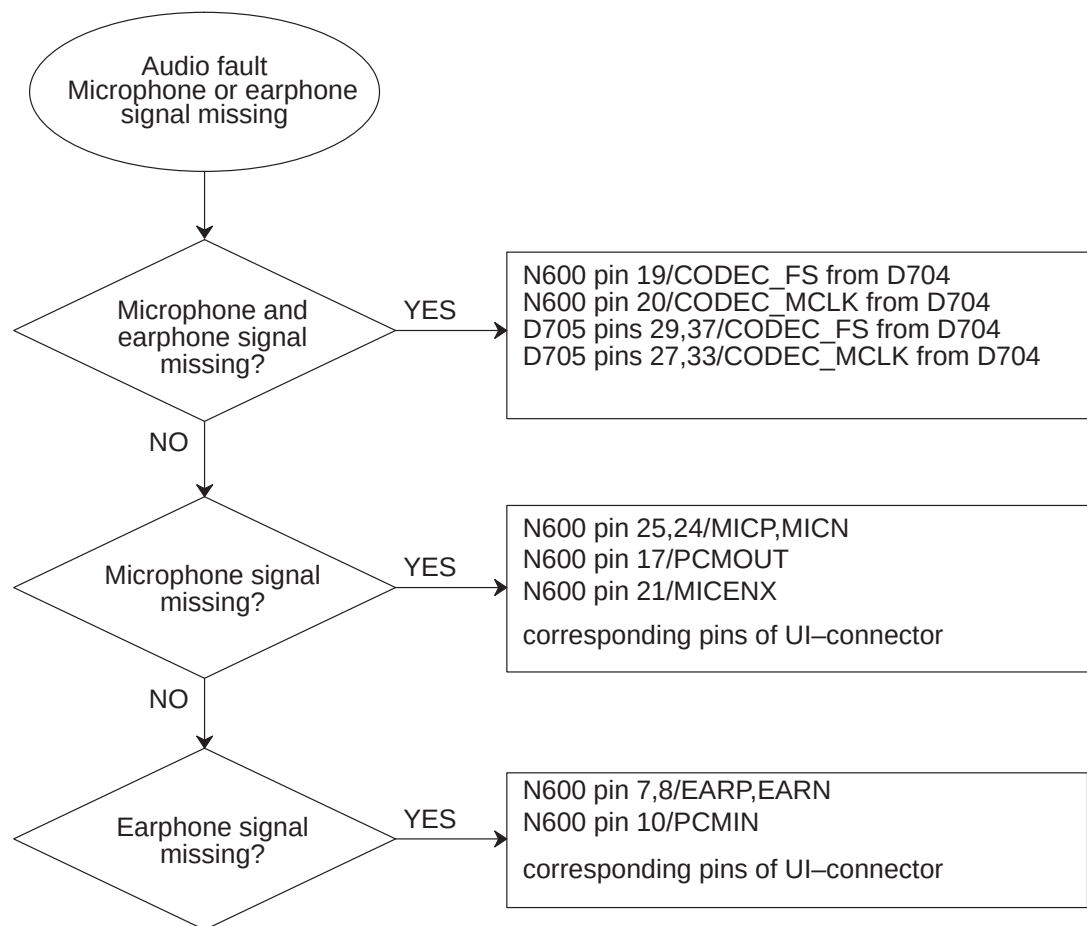


Troubleshooting Diagram; Flash Programming, part 4

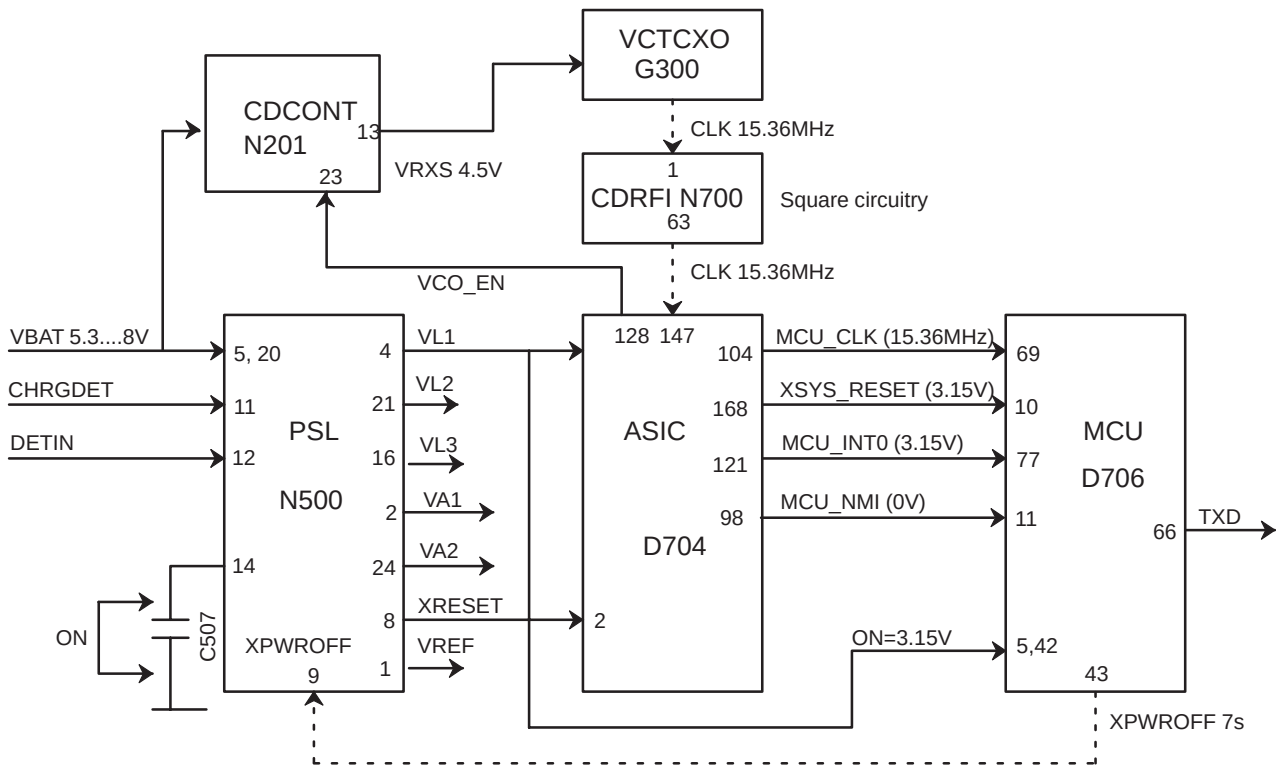


Troubleshooting Diagram; PWR Button Fault

Troubleshooting Diagram; Audio Fault



Power Up Sequence Diagram



PSL_+3V(N500)

Output voltages must stay high at least 7seconds when power is switched on.

If no; check C507.

If it is OK; replace PSL_+3V(N500).

If the XRESET line doesn't rise check DETIN. The voltage value at this pin should be between 1.46V and 1.72V.

ASIC(D704)

When XRESET and CLK are supplied to the ASIC(D704) but MCUCLK or XSYS_RESET to the MCU(D706) are not supplied; replace ASIC(D704).

MCU(D706)

If MCU_CLK and XSYS_RESET are supplied from ASIC(D704) but TXD line (MBUS) doesn't rise and solder joints of the MCU(D706) are good, check that MCU_INT0 is high (3.15V) and MCU_NMI is low (0V), if that is the case then replace MCU(D706).

If TXD pin 66 of the MCU(D706) goes high but doesn't stay there at least 7seconds.

The power of the phone can be kept ON by:

- Connecting PSL +(N500) pin 14 to the ground.

Now it is possible to use service software for troubleshooting.

Repairing Instructions for Flash Faulty Units

1. When the phone doesn't start (power off after 7seconds and probably no MBUS connection) check following things:

VBATT is connected to the PSL_+3V(N500)

XRESET rises to 3.15V

VL1 is 3.15V

32KHz clock is running.

VRXS(4.5V) is connected to the VCTCXO and the crystal frequency is 15.36 MHz

XSYS_RESET signal rises to 3.15V

MCU_CLK signal is 15.36 MHz

MCU_NMI line stays low(0V)

MCU_IRQ0 line stays high(3.15V)

If all these happens, the MCU(D706) will supply power OFF pulses to the PSL_+3V(N500) and the power will stay on.

In faulty conditions, most likely MCU_IRQ0 stays low(0V), which means that interrupt is generated all the time.

In this case check data and address lines of ASIC(D704), MCU(D706) and memory circuits for short circuits or unconnected pins.

2. When FLASH programming is not succeed, check following things:

System connector(X701) pins 6, 7, 14 are soldered and there are no short circuits.

Flash programming voltage (VF=12V) is connected to the FLASH(D709) pins 23 and 39.

The data and address lines of the FLASH(D709) are soldered.

EEPROM(D703) should be OK because of the initialization (program parameters are loaded always when program is loading the first time).

Calibrate Battery Voltage (VBATDET)= 6.0V

a) Check R505, R504

b) Check PSL_+3V(N500) pin 23

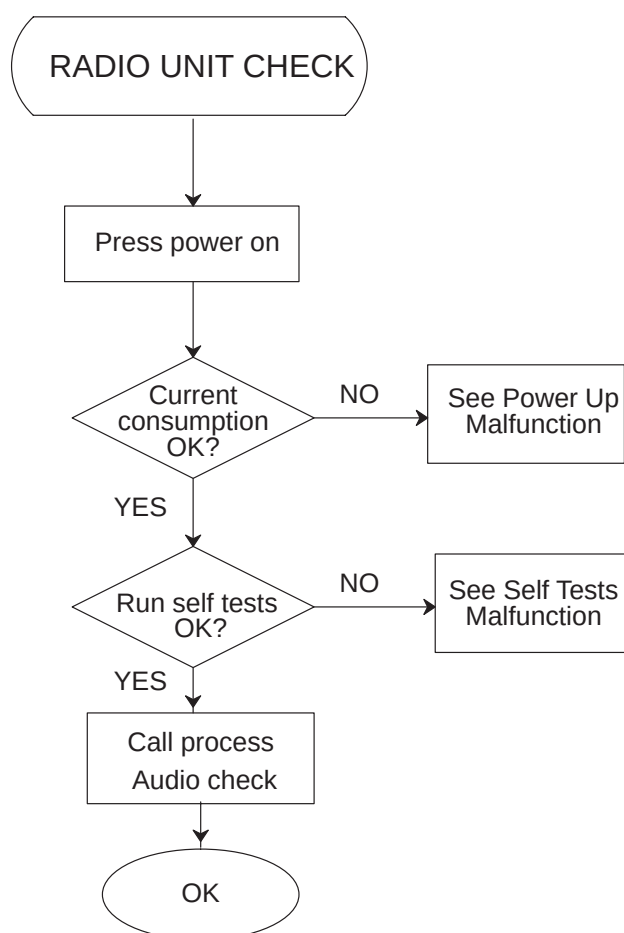
c) Check MCU(D706) pin 52

Calibrate Charge Voltage (VC)= 6.0V

a) Check R502, R501, R508

b) Check MCU(D706) pin 53

Troubleshooting Diagram; Power Up and MCU Self tests Malfunctions



Power Up Malfunction

Basically there are two different problems that could occur while powering up the phone. First, the current consumption is almost zero all the time. Probably the fault is at the power circuit PSL_+3V(N500). Check all PSL_+3V(N500) connections including VBATT line.

Second, the phone's current consumption is normal for 7seconds and goes to zero after that time. The reason for this is the watchdog.

1.0 Is MCU's clock running?

Check with oscilloscope if there is a clock signal at MCU(D706) pin 69. It should be a square wave signal, 50% duty cycle, 3Vpp and 15.36MHz. See Figure 1. Is the clock running?

YES! Go to 2.0 / **NO!** Go to 1.1

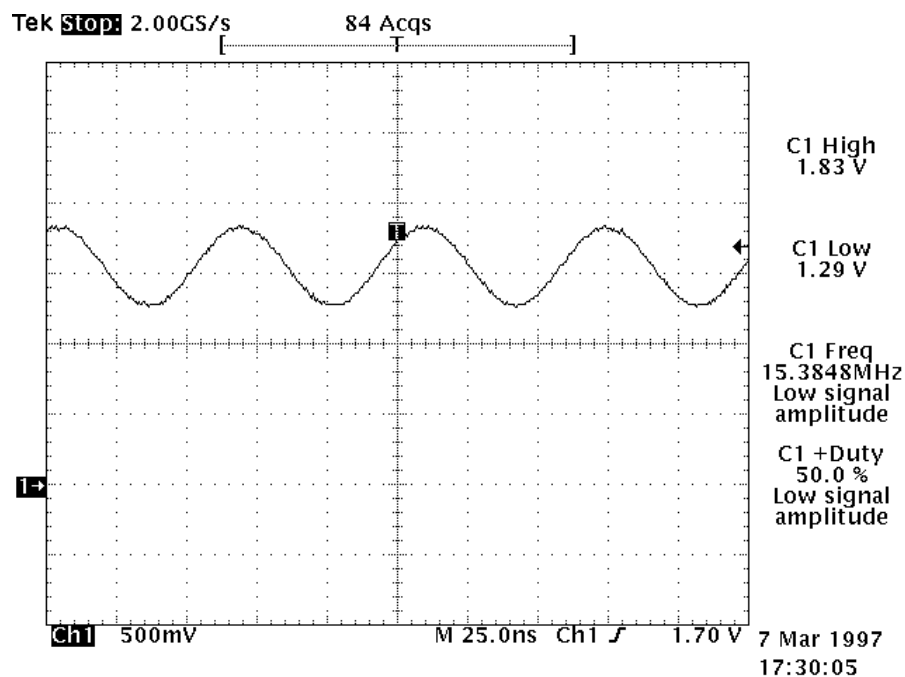


Figure 1

1.1 Is VCTCXO running?

- Measure CDRFI(N700) pin 1. See Figure 2. Is there a 15.36MHz sine wave signal?
- **YES!** Go to 1.2 / **NO!** Go to 1.11

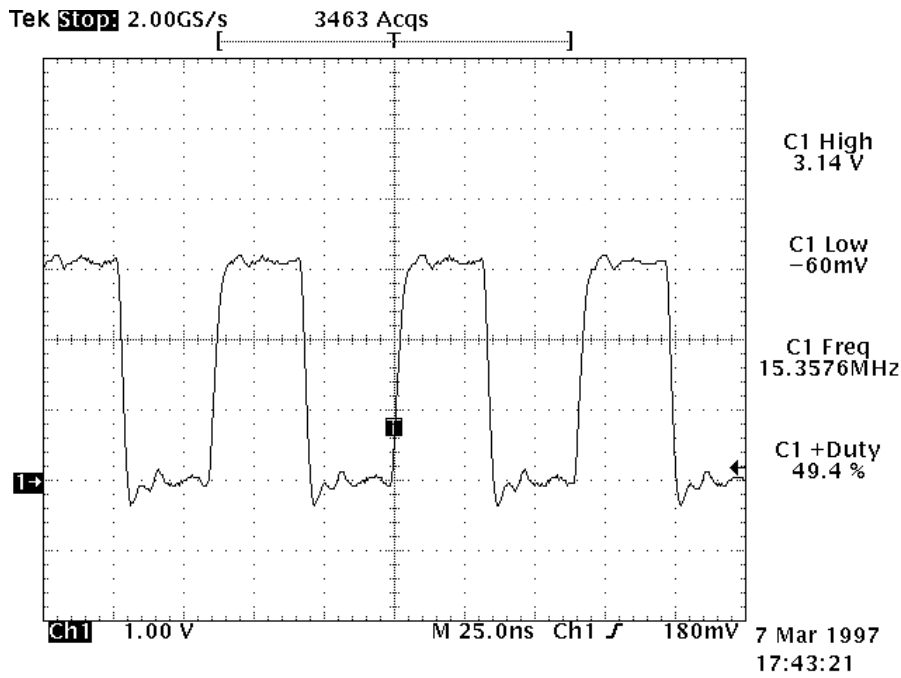


Figure 2

1.11 Check VCO_EN is high (3.15V) CDCONT(N201) pin 23.

1.12 Check VCTCXO(G300) waveform at CDCONT(N201) pin 35 looks like Figure 3. Also check that VRXS line is 4.5Vdc at CDCONT(N201) pin 13. If all these conditions are meet check solder joints for shorts and opens, if they are OK replace CDCONT(N201).

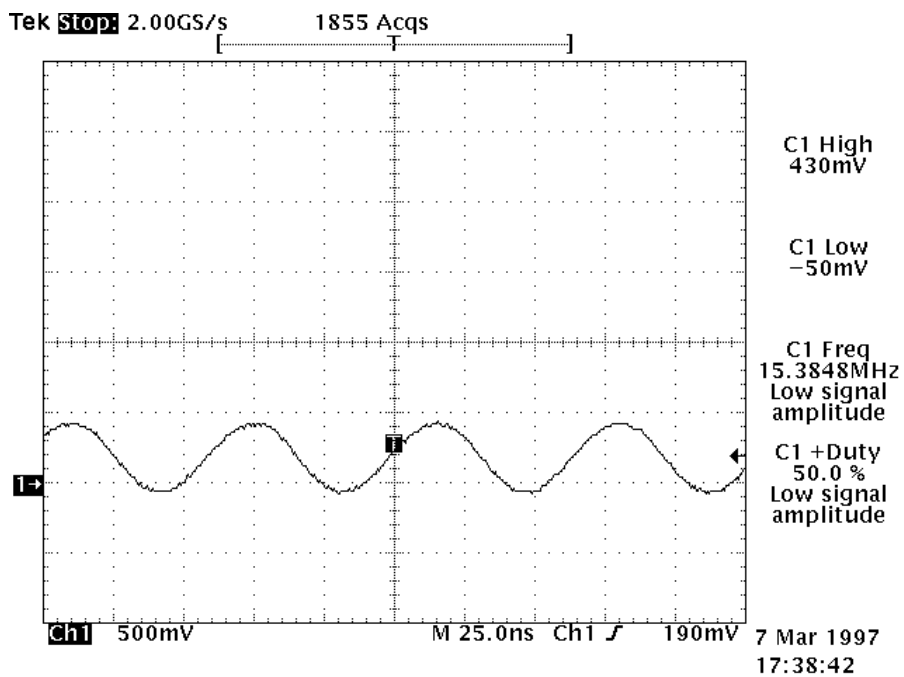


Figure 3

1.2 Check CDRFI(N700) pin 63. See Figure 4. Is there a 15.36MHz clock signal present?

– **YES!** Go to 1.22 / **NO!** GO to 1.21

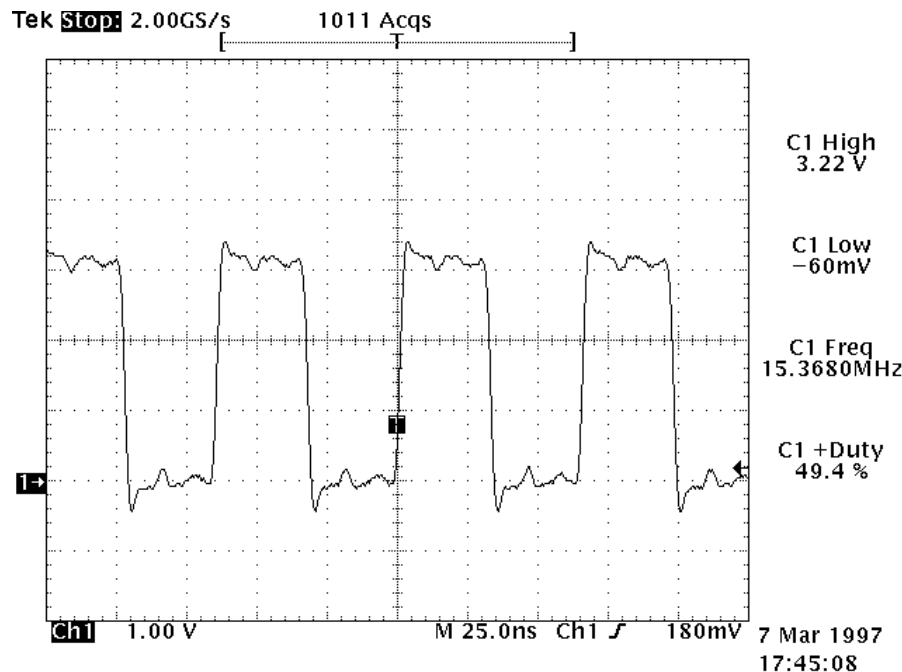


Figure 4

1.21 Check this signal solder joints, if OK replace CDRFI(N600).

1.22 Check connections between ASIC(D704) and MCU (D706), especially ASIC(D704) pin 104 and MCU(D706) pin 69. If no clock is present and connection looks OK replace ASIC(D704).

2.0 Are MCU's supply voltages OK?

Measure MCU(D706) supply voltages from pins 5 and 42 (nominal 3.15V $V_{dc} \pm 0.15 V_{dc}$). Are supply voltages right?

YES! Go to 3.0 / **NO!** Go to 2.1

2.1 Check PSL_+3V(N500) VL1(3.15V) pin 4

3.0 Is XSYS_RESET signal OK?

Check XSYS_RESET at MCU(D706) pin 10. While a high (about 3.15 V_{dc}) is ok, GO to 4.0. If zero then MCU(D706) is in reset, GO to 3.1.

3.1 Is XPWR_RESET signal from PSL_+3V(N500) OK?

– Check XPWR_RESET line from PSL_+3V(N500) pin 8. If it is high GO to 3.12, if zero GO to 3.11.

3.11 Check PSL_+3V pin 12. Voltage should be between 1.46V and 1.72V. if not check R500, R503 and VBATT voltage(5.3...8 V_{dc}) *NOTICE! Measure pin 10 from the PSL_+3V(N500) with oscilloscope. That is watchdog signal coming from MCU(D706). There should be rising edges time to time.* If all these are OK and still XPWR_RESET is low replace the PSL_+3V(N500).

3.12 Check reset line for shorts and open between MCU(D706) and ASIC(D704), and between PSL_+3V(500) and ASIC(D704). If OK replace ASIC(D704).

4.0 Is 32KHz clock running?

Check with oscilloscope if there is a 32.768KHz clock signal at ASIC(D704) pin 87. It should look like Figure 5.

YES! Go to 5.0 / **NO!** Go to 4.1

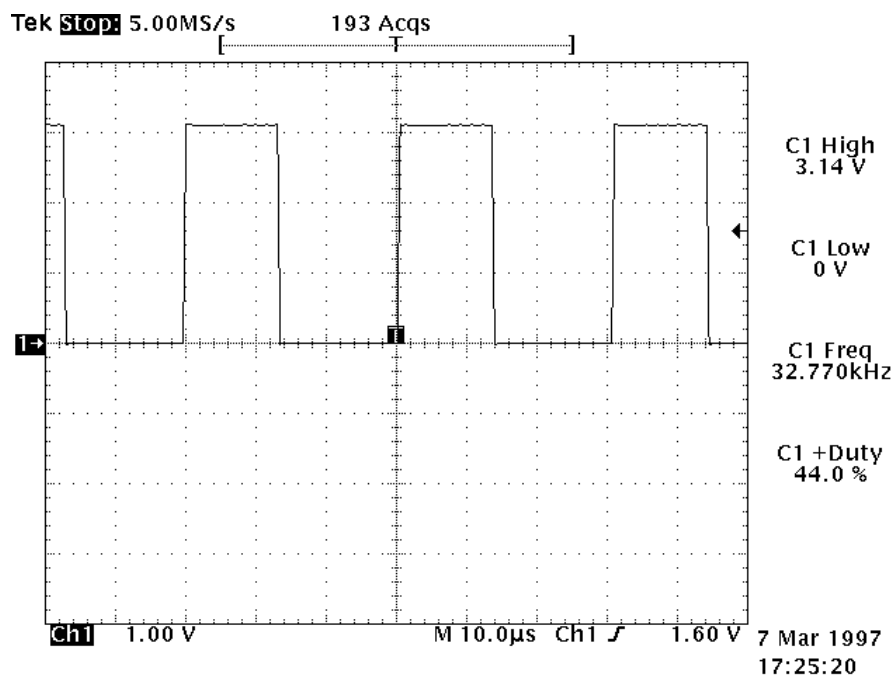


Figure 5

4.1 Check solder joints in ASIC(D704) pins 36, 37, 46, 125. Also check B700, C744, C745, R837, R757, If they are OK replace B700. If problem persists replace ASIC(D704).

5.0 Check all supply voltages!

Measure all power supply voltage lines VL1(3.15V), VL2(3.15V), VL3(3.15V), VA2(3.15V) and VREF(3.15V).

Are voltages right? **YES!** Go to 6.0. / **NO!** Read ahead!

If any voltage is not the right one, check corresponding transistor. VL1 (V500), VL2(V502) and VL3(V501).

Check also all major circuits supply voltages MCU(D706), ASIC(D704), PSL_+3V(N500), DSP(D705), CDRFI(N700) and CODEC(N600).

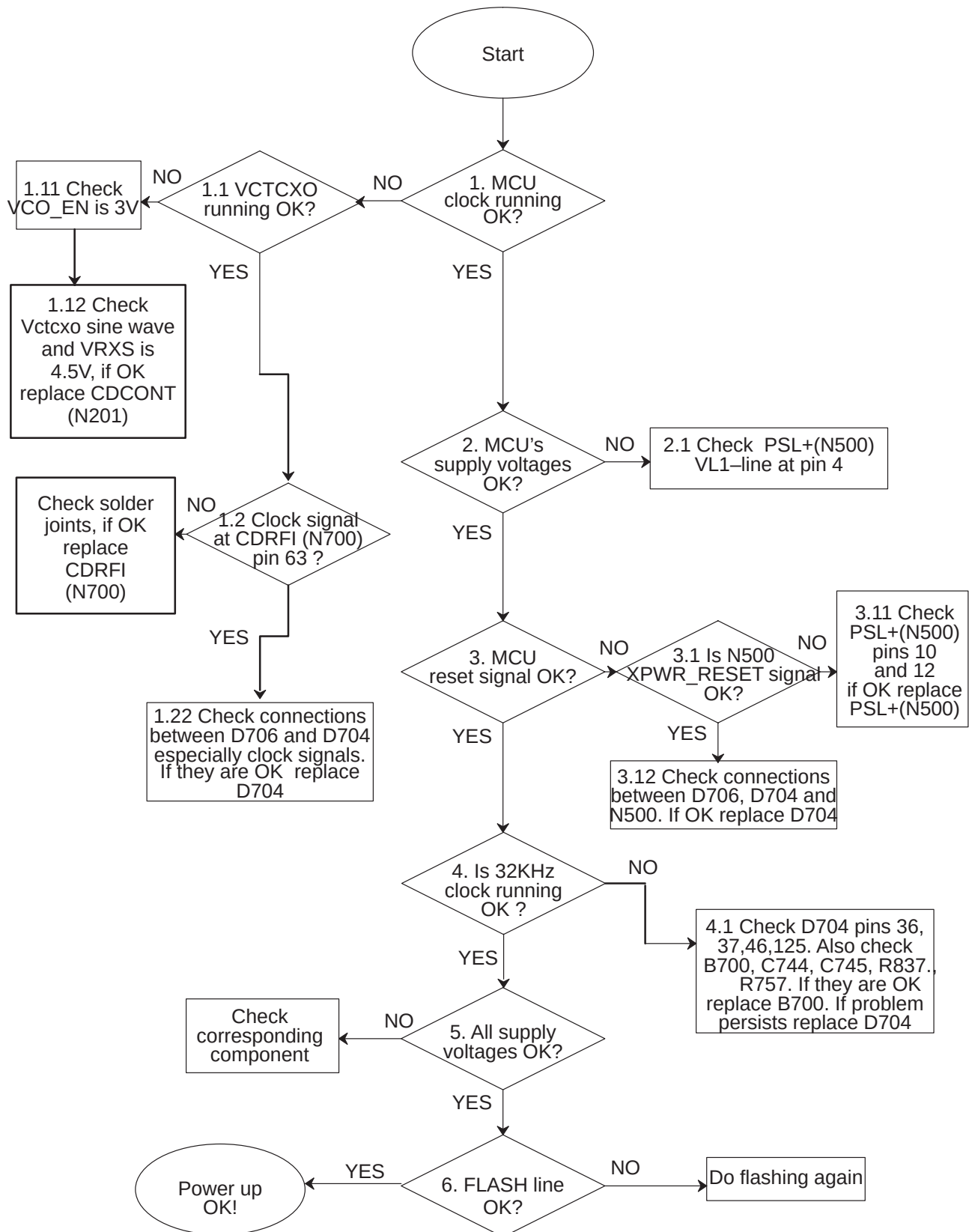
6.0 FLASH-line OK? Power up function OK!

YES! Power up function OK! / **NO!** Do flashing again.

This table might help to locate power pins on main circuits.

Circuit	Number	Pins	Supply voltage signal
MCU	D706	5,42	VL1
ASIC	D704	13,22,27,44,60,65,74,88,103	VL1
	D704	109,117,132,146,151,161,176	VL1
DSP	D705	8,11,36,39,49,64,76,87,90	VL2
CDRFI	N700	32,33,60,62,2,6,8,19	VL3
CODEC	N600	2,3	VA2
	N600	15	VL1
FLASH	D709	30,31,11	VL1
RAM	D700	28	VL1
EEPROM	D703	7	VL1

Troubleshooting Diagram; Power Up Malfunction



Important Information

This section contains information that might be helpful while troubleshooting an HD881 phone. However it is not needed to troubleshoot power up problems.

9.8304MHz clock

This clock is "ON" when the phone is set to CDMA non-slotted mode and it is "OFF" when the phone is set to AMPS mode. It is generated inside the CDCONT(N201) from the 15.36MHz. The waveform signal coming out from the CDCONT(N201) pin 40 should look like Figure 6.

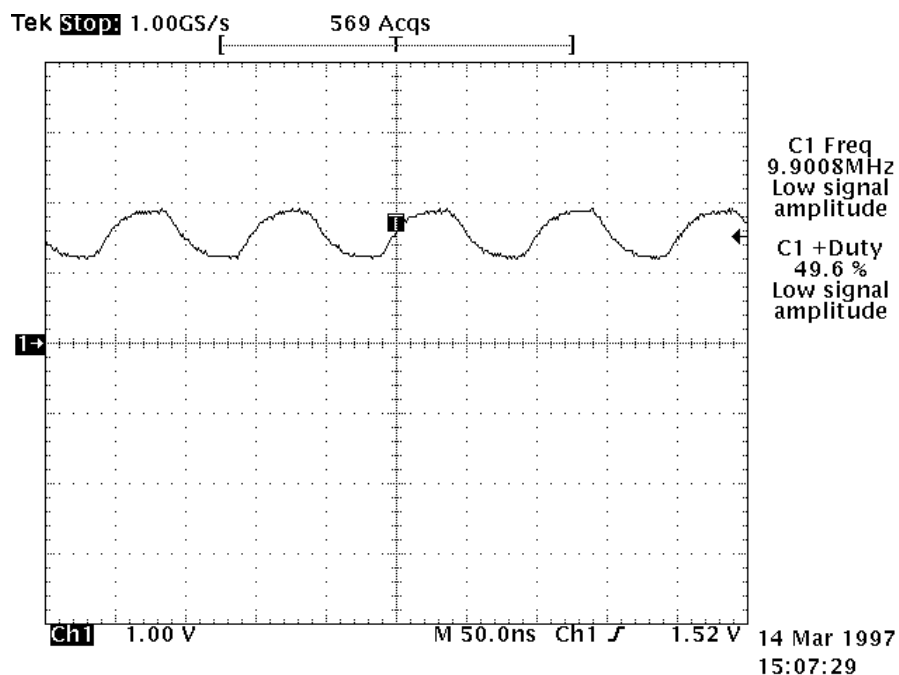


Figure 6

Then this signal is fed to the CDRFI(N700) squaring circuit on pin 3 to get the final 9.8304MHz clock signal that will go to the ASIC(D704). This clock should look like Figure 7.

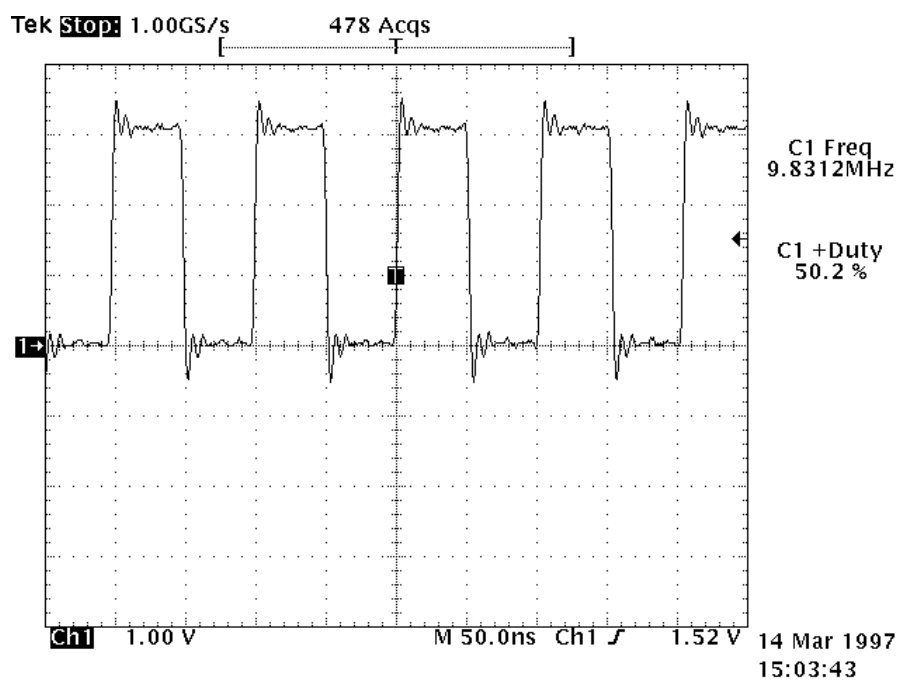


Figure 7

Transmitter Troubleshooting

Introduction

Troubleshooting the NHD-4 transmitter is very straight forward. Operation of the transmitter circuit changes little from AMPS to CDMA mode, only the nature of the signal transmitted is distinctly different. A substantial amount of information regarding the health of the transmitter can be determined with just a simple DMM. The detector voltage will provide you a sound estimate of the output power. Collector and base voltages will inform you if biasing is correct on the gain stages (drain and gate for CLY-10 V113). And the various control signal had their DC voltage characteristics detailed in the Functional Description. An RF probe can also be used to quickly determine if a gain stage or filter is functioning properly.

Below are a number of techniques to test the transmitter, beginning with a means to simply turn it on. Service Software features that provide manual transmitter controls are detailed. Node voltages RF power levels and a chart of gains and losses are provided. Means to test the various TX control features are explained.

Service Software Quick Checks

The Service Software has a number of features that allow you to quickly test out the functionality of the transmitter in both the CDMA and AMPS modes. The following two quick checks simply turns the transmitter on in either of these modes.

AMPS TX Quick Checks with Service Software

From the Service Software select the AMPS Quick Checks option from the Testing menu. A window will appear. Within this window are numerous AMPS related controls for the phone, including a means to turn on the AMPS transmitter. This is done by simply selecting the AMPS power level 0-2 through 7. Measure the output power using a spectrum analyzer, power meter or RF communications test set.

AMPS TX Power Level	AMPS TX Output Power (dBm)
0-2	27.0
3	23.0
4	18.0
5	14.0
6	10.0
7	8.0

CDMA TX Quick Checks with Service Software

The Service Software contains a Quick Check for the CDMA TX. From the Test menu choose the CDMA Quick Test selection. A sub menu will appear. Select the CDMA TX Quick Check. A window will appear instructing you to feed the transmitter output into either a spectrum analyzer or CDMA test box. Selecting the "TEST" soft button will turn on the CDMA transmitter to its maximum power, approximately 24 dBm. If not, then there is either some gain missing or a failure to provide the appropriate input signal.

It should be noted that in CDMA operation, proper output power measurements require that the bandwidth be taken into strict consideration. CDMA output power readings must be performed across a 1.23 MHz band. A spectrum analyzer used for such measurements must have the functionality to read band power. Otherwise, a CDMA signal simply appears as an amplified noise floor, 1.23 MHz wide. For maximum CDMA TX output power, the peak of this noise-like signal will be approximately 10 dBm. CDMA test boxes have this capability built in.

Manual Output Power Control

The following two tests provide means to manually control the output power of the NHD-4 transmitter in either the AMPS or CDMA modes.

AMPS TX Gain Control – Manual Control

The AMPS transmitter gain is controlled from the TXI_REF PDM. This PDM has a manual control within the AMPS Quick Checks window of the Service Software Test menu. With the phone in AMPS Troubleshooting Mode the transmitter output power can be manipulated with this PDM control. The table below details approximate PDM values, in decimal, necessary to achieve corresponding power levels. These values will vary from phone to phone.

AMPS TX Output Power (dBm)	TXI_REF PDM decimal value
30	00
27	238
24	208
21	176
18	166
15	160
12	155
9	152
6	151

CDMA TX Gain Control – Manual Controls

As the name suggests, the CDMA TX Manual Gain Control mechanism of the Service Software provides a means to manually manipulate the output power of the CDMA transmitter. This test is convenient for testing the two gain control functions of the CDMA transmitter, the CDAGCT IC and Auxiliary AGC.

You can find this control within the CDMA Quick Checks selection of the Tests menu of the Service Software. The output power is controlled by adjusting the slide bar up and down, or manually entering numeric values within the text edit box. Use a spectrum analyzer with a 2 MHz span to view the transmitter output.

This test is adjusting the CloopRef register value, a value that determines the difference between the received power into the mobile and the transmit power out of the mobile. Artificially adjusting it, as this test does, results in a change in the transmit power level. For this test maximum CDMA output power, about 24 dBm, is achieved with a decimal value of approximately 105. Minimum CDMA output power is achieved with a decimal entry of about 25. At this level the CDMA signal will be as low as the noise floor.

Detector DC Voltage Check – AMPS

Measuring the detector voltage, TXI, is a great way to test transmitter output power without actually reading the RF output power. Probing the detector with a DMM at N202 pin 1 will provide a DC voltage that directly corresponds to the amount of RF power sampled by the detector (V114). This is a good means to assist in isolating transmitter faults. Whether or not the detector voltages are valid will inform you if power losses are occurring before or after the final PA stage (CLY-10, V113).

The following table shows typical detector output voltages for each AMPS output power level.

AMPS Power Level	AMPS Output Power (dBm)	Detector Voltage TXI at N202 pin 1 (V)
0-2	27	0.87
3	23	1.35
4	18	1.80
5	14	1.99
6	10	2.13
7	8	2.17

DC Node Voltage Checks

Typical nodal voltages are listed below. The phone must be at AMPS output power level 2 or maximum CDMA output power when measuring node voltages. These two states can be achieved by using the AMPS or CDMA Troubleshooting Modes.

NODE	CDMA VDC	AMPS VDC
VTXS – DC supply at C144	4.40	4.40
VTXT – DC supply at R120	5.30	5.30
V114 – Detector output (TXI) at N202 pin 1	1.20	1.10
V114 – Detector supply at R127 (VTXS)	4.40	4.40
V113 – CLY-10 PA supply at C160 (VRFT)	6.20	6.20
V113 – CLY-10 PA gate at R138 (VGG)	-2.70	-2.30
V112 – 3rd Gain stage collector at C157	6.00	6.00
V112 – 3rd Gain stage base at C164	0.70	0.70
V112 – 3rd Gain stage supply at R117	6.3	6.20
V110 – 2nd Gain stage collector at C154	2.68	2.67
V110 – 2nd Gain stage base at R129	0.72	0.72
V111 – 1st & 2nd Gain stages supply at C108	4.70	4.70
V111 – 1st Gain stage collector at C146	3.85	3.83
V111 – 1st Gain stage base at R128	0.75	0.75
V106 – AT-109 atten. – supply at C129 (VTXS)	4.40	4.40
V106 – AT-109 atten. – control at C109 (VC)	3.50	4.35
N100 – Bias to the CDAGCT IC at C133	3.90	3.90
RFE2 at V107 emitter	0.00	3.10
VRFT – Battery voltage at C142	6.80 *	6.80 *
VNEG – Gate Volt. Delay at R111	-4.12	-4.05
TX_PUNC – Puncture Control at V102	3.12	3.12
TX_IREF – Control current reference at C115	3.60	3.50
TX_ICT – Control current at C100	3.60	3.50

Note This is the Battery voltage. It directly reflects the power supply voltage to the phone. It will only be 6.8 V when the DC supply to the phone is 6.8 V.

Note: The position of the probe's GND pin is critical to obtain correct readings. The GND pin MUST be touching the GND plane immediately next to the point being measured!!

RF Node Power Levels

A high impedance passive RF probe may be used with a spectrum analyzer to obtain the RF node power levels along the transmitter chain. The author recommends a passive probe with a 500 ohm tip. The following levels are based on a transmitter output at AMPS power level 7. Maintain a 1.0 MHz span on the spectrum analyzer. A CDMA test box with spectrum analyzer capabilities will do.

The RF power levels published below were found with a passive probe with the 500 ohm tip. The blank column is reserved for values the user will obtain with their own probe.

Node	Frequency (MHz)	Power Lvl HP10020A 500 ohm tip (dBm)	Power Lvl (your own) (dBm)
N100 – CDAGCT pin 8	180.00	-22.5	
N100 – CDAGCT pin 2	926.52	-30.4	
N100 – CDAGCT pin 31	836.52	-35.0	
N100 – CDAGCT pin 32	836.52	-36.6	
V106 – AT-109 pin 3 (input)	836.52	-36.8	
V106 – AT-109 pin 7 (output)	836.52	-49.0	
Z100 – TX SAW pin 2 (input)	836.52	-45.0	
Z100 – TX SAW pin 5 (output)	836.52	-45.0	
V111 – 1st Gain stage – base	836.52	-40.0	
V111 – 1st Gain stage – collector	836.52	-28.0	
V110 – 2nd Gain stage – base	836.52	-22.8	
V110 – 2nd Gain stage – collector	836.52	-8.5	
Z101 – TX SAW pin 5	836.52	-14.6	
Z101 – TX SAW pin 2	836.52	-12.8	
V112 – 3rd Gain stage – base	836.52	-26.5	
V112 – 3rd Gain stage – collector	836.52	1.7	
V113 – CLY-10 PA gate	836.52	-13.3	
V113 – CLY-10 PA drain	836.52	6.7	
V710 – Isolator pin 2 (input)	836.52	5.7	
Z102 – Duplexor TX port	836.52	6.0	
Z102 – Duplexor ANT port	836.52	6.0	

Testing CDMA TX Gain Limiting

To test the CDMA TX Gain Limiting control perform the following steps:

1. Place the phone in the CDMA Troubleshooting Mode.
2. With an oscilloscope probe the LIM_ADJ line at C807.
3. Adjust the gain of the CDMA transmitter using the CDMA TX manual gain control mechanism found in the Service Software.
4. The LIM_ADJ line will remain at about 3.2 VDC until the TX output power reaches its limit, approximately 24 dBm. At this point the LIM_ADJ line will toggle continuously, appearing as a square wave 3.2 Vpp with an approximate frequency of 400 Hz.

Testing Dynamic TXB

To test the Dynamic TXB functionality, perform the following steps:

1. Place the phone in the CDMA Troubleshooting Mode.
2. Use the Service Software CDMA TX manual gain controls to achieve 10 dBm CDMA TX output power.
3. Read the total current draw of the phone. It should be approximately 530 mA.
4. Increase the CDMA TX output power to 23 dBm. The current draw should rise to approximately 690 mA.

Note the difference is about 150 mA, which is the difference between the two current biasing levels.

	CDMA TX 10 dBm (mA)	CDMA TX 23 dBm (mA)	AMPS Power Level 7 (mA)	AMPS Power Level 2 (mA)
Current Draw	530	690	400	610

Testing CDAGCT IC (N100) Gain Control

To test the gain control abilities of the CDAGCT IC (N100) do the following:

1. Place the phone in the CDMA Troubleshooting Mode
2. Observe the TX output with a spectrum analyzer or CDMA test set. Be sure to read bandpower over a 1.23 MHz band.
3. Use the CDMA TX manual gain control found in the Service Software to adjust the output power from its minimum (noise floor) to 15 dBm.
4. Observe the TX_Gain voltage at C213 and the TX_ICT current as a voltage drop across R116. The table below details approximate values that should be read.

CDMA TX Output RF Signal Level (dBm)	TX_GAIN Voltage at C213 (V)	TX_ICT Control Current (mA)	TX_ICT (as voltage drop across R116) (mV)
15	1.78	0.700	70.0
10	1.80	0.560	56.0
-5	1.87	0.298	29.8
-20	1.93	0.171	17.1
-35	2.00	0.093	9.3

Testing Auxiliary AGC

To test the gain control abilities of the Auxiliary AGC feature, perform the following steps:

1. Place the phone in the CDMA Troubleshooting Mode
2. Observe the TX output with a spectrum analyzer or CDMA test set. Be sure to read bandpower over a 1.23 MHz band.
3. Use the CDMA TX manual gain control found in the Service Software to adjust the output power of the phone from 15 dBm to 23 dBm.
4. Observe the VC voltage at C109 and the AGC_REF PDM voltage at C716. The table below details approximate values that should be read.

CDMA TX Output Power (dBm)	AGC_REF PDM (decimal value)	AGC_REF PDM voltage at C716 (V)	VC at C109 (V)
23	0	0.798	3.28
21	34	0.583	2.81
19	60	0.456	2.53
17	79	0.367	2.33
15	85	0.333	2.26

Hints and Suggestions

The 3rd stage (V112) is sensitive to shorts of the DC bias line. Accidentally shorting the collector to ground always blows the 5.6 ohm bias resistor (R117) but doesn't harm the transistor.

AMPS Receiver Troubleshooting

Introduction

Troubleshooting the NHD-4 AMPS receiver isn't unlike troubleshooting the AMPS receiver on any other Nokia phone. In fact, NHD-4 uses the same FM receiver IC as many other Nokia phones. So long as the NHD-4 phone is in an AMPS RX mode, this receiver will be on. The following tests detail ways to make the AMPS receiver operational and test its functionality.

Tests and Quick Checks

The Service Software software package contains a quick test for the AMPS receiver. When selected, the software prompts you to send a modulated carrier into the phone at a -65 dBm signal level. Hitting the "Test" soft key prompts the software to read the RSSI voltage level that the CDRFI IC has A/D converted into a digital signature. If the digital value falls within the range which a -65 dBm signal should, it is a good bet that the AMPS receiver is working properly. There is still a chance that the demodulated baseband ANARX signal (the audio) is corrupt, but you do know the rest of the AMPS receiver is functional.

If the RSSI values are less than the ranges stated, then there is an AMPS RX sensitivity problem. Most likely a component or solder joint along the AMPS RX receiver path has failed. The possibility exists that the error is in the baseband A/D conversion. To ensure that the error is in the RF it is recommended that the remaining tests below be performed until the error is uncovered.

If the RSSI values are greater than the ranges stated than additional RF energy above the stated input level is entering the RX path. Check the level of the signal generator used for the test. It may be sourcing more RF power than was requested by the test. Ensure that cable losses have been properly accounted for.

Setting Up the AMPS Receiver Test

To troubleshoot the AMPS receiver first remove the shields. Apply power and service cables to the phone and turn it on. Initiate the AMPS Troubleshooting Mode from Service Software. Then feed a -65 dBm 881.52 MHz signal modulated with 8 kHz FM and 1 kHz audio into the RF port of the phone via the bottom connector. A stand alone RF signal generator should do the trick, or a CDMA test box with this functionality. Do not forget to account for the signal loss between the signal generator and the phone.

RSSI Check

The voltage on the ungrounded end of C13 directly represents the RSSI of the phone. Checking this voltage will provide another quick indication of the health of the AMPS RX module. With the -65 dBm modulated signal mentioned above this voltage should be approximately 2.00 V.

The possibility exists that the AMPS RX is working fine with a -65 dBm input, but has lost sensitivity and fails at lower input powers. You may wish to perform this test at higher or lower input signal levels. The following table details the RSSI voltage vs. input signal levels. Keep in mind that there will be variations in the voltage levels from phone to phone, but these are good approximations.

Input Signal Level (dBm)	RSSI Voltage (V)
-45	2.32
-50	2.31
-55	2.26
-60	2.16
-65	2.00
-70	1.89
-75	1.78
-80	1.65
-85	1.54
-90	1.41
-95	1.26
-100	1.17
-105	1.07

If the RSSI DC voltages are significantly less than the ranges stated then there is an AMPS RX sensitivity problem. A total AMPS RX failure would yield about 1.00 V for this test for most input RF power levels. Most likely a component or solder joint along the AMPS RX receiver path has failed. Continue the DC Voltage Quick Checks to help determine if any of the devices aren't biased correctly.

If the RSSI values are significantly greater than the ranges stated then additional RF energy above the stated input level is entering the RX path. Check the level of the signal generator used for the test and ensure that cable losses have been properly accounted for. Also check for any undesired oscillations.

DC Voltage Checks

Check the following DC voltages with the -65 dBm modulated signal still fed into the phone and the Service Software AMPS Troubleshooting Mode initiated.

- The bias voltage on the AMPS RX IC (D1), pin 4 should be approximately **4.40 V**.

If not, first ensure that the phone is in the AMPS Troubleshooting Mode. Check the VRXA supply voltage at C219, or CDCONT (N201), pin 42. If fault is found with this DC supply then refer to the AGC Troubleshooting Manual to determine if there is a problem with the CDCONT voltage regulators.

- Check the 1st IF gain stage V9:–

The voltage on the collector, pin 1 should be approximately **3.30 V**.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Inspect V9, R30 and R31. Ensure that VRXAM is approximately 4.15 V at R31

The voltage on the base, pin 3 should be approximately .97 V.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Inspect V9, V4, L13, L11, R4, R5, R13, R14, and R15. Ensure VRXM is at about 4.15 V at R13, and VRXAM is about 4.15 V.

The voltage on the emitter, pins 2 and 4 should be approximately **0.25 V**.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Inspect V9, L14, R25, and R28.

- Check the LNA, V12:–

The voltage on the collector should be approximately **3.70 V**.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Ensure VRXM is at about 4.15 V at R833. Inspect V11, V12, L20, R33, R34, R38, and R833.

The voltage on the base should be .82 V.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Ensure VRXM is at about 4.15 V at R833. Inspect V11, V12, L21, L22, R33, R35, and R833.

- Check the control voltages on the RF Gain Switches N701 and N702. Pin 1 on both should be approximately **3.80 V**.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Ensure VRXM is at about 4.15 V at R832. Inspect N701, N702, V1, V708, R775, R777, R779, R781, R783, R803, R830, R831, and R832.

- Check the SWAGC line at R830. It should be logic level low, approximately .0 V.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Ensure VRXM is at about 4.15 V at R832. Inspect V708, R765 and R830. Ohm out line from R765 to the ASIC N704 pin 94.

- Check the RX_CAL line at R783, It should be logic level high, near **2.75 V**.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Ensure VRXM is at about 4.15 V at R832. Inspect V1, V708, R6, R765, R783, and R785. Ohm out the RX_CAL line from pin 114 of the ASIC N704 to R785.

Chart of AMPS RX DC Node Voltages

The following chart summarizes the node voltages of the AMPS RX when the phone is in the AMPS RX/TX Mode with a 881.52 MHz signal input of -65 dBm, modulated with 8 kHz FM, 1 kHz audio.

Node	Voltage (V)
D1 – AMPS RX IC, pin 4	4.40
V9 – collector of 1st IF amp, pin 1	3.30
V9 – base of 1st IF amp, pin 3	0.97
V9 – emitter of 1st IF amp, pins 2, 4	1.12
V12 – collector of LNA	3.70
V12 – base of LNA	0.82
RF Gain Switches N701 and N702, pin 1	3.80
RF Gain Switches N701 and N702, pin 8	0.00
SWAGC line at R830	0.00
RX_CAL line at R783	2.75

Demodulation Test

If you have an oscilloscope available you may use it to do a visual check on the demodulated 1 kHz tone on the ANARX+DA line. Again feed in the modulated -75 dBm, 881.52 MHz, 8 kHz FM, 1 kHz audio RF signal into the receiver and initiate the AMPS Troubleshooting Mode from Service Software. Use a standard scope probe at C1 to look at the 1 kHz tone. It should appear as a clean sine wave of approximately 380mVpp. Step down the input RF power. At about -90 dBm the sine wave will begin to become a bit fuzzy. At -105 dBm the waveform will be fuzzy, but still distinguishable.

If not, confirm that the phone is in the AMPS Troubleshooting Mode. Ensure the RF signal is modulated correctly and of the requested signal level. Inspect R2, C1 and C10.

RF Node Power Checks – AMPS Mode

A high impedance passive RF probe may be used with a spectrum analyzer to obtain the RF nodal power levels along the receiver chain. The following levels assume a -65 dBm, 881.52 MHz, unmodulated tone input into the receiver. Maintain a 1.0 MHz span on the spectrum analyzer. A CDMA test box with spectrum analyzer capabilities will do.

The RF power levels published below were found a passive probe with the 500 ohm tip. The blank column is reserved for values the user will obtain with their own probe.

Node	Frequency (MHz)	Power Lvl HP10020A 500 ohm tip (dBm)	Power Lvl (your own) (dBm)
44.545 MHz osc. at D1, pin 2	44.545	-10	
AMPS RX IC D1 pin 16	45	-62	
SAW Z3 pin 3	45	-61.5	
SAW Z3 pin 6	45	-57.5	
Diode V10 pin 3/L15/R29/R30	45	-90	
1st IF Amp V9 collector, pin 1	45	-90	
1st IF Amp V9 base, pin 3	45	-105	
Mixer T1 pin 4 – IF	45	-80	
Mixer T1 pin 8 – LO	926.52	-19	
Mixer T1 pin 5 – RF	881.52	-75	
RF Switch N701 pin 7 – output	881.52	-75.5	
RF Switch N701 pin 5 – input	881.52	-75.5	
LNA V12 collector	881.52	-68	
LNA V 12 base	881.52	-90	
RF Switch N702 pin 7 – output	881.52	-85.5	
RF Switch N702 pin 5 – input	881.52	-85.5	
Duplexor Z102, RX In pin	881.52	-92	
Duplexor Z102, ANT pin	881.52	-89	
Coax W400 Antenna input	881.52	-87	
Coax W400 Connector input	881.52	-88	

CDMA Receiver Troubleshooting

Introduction

Troubleshooting the CDMA receiver of the phone is unique, but not complicated. The following tests detail numerous ways that the CDMA receiver functionality can be verified, all using standard test equipment. No special CDMA signal generators or measurement equipment are necessary to verify the CDMA receiver.

CDMA RX Quick Test with Service Software

The Service Software software package contains a quick test for the CDMA receiver. When selected, the software prompts you to send a CW carrier into the phone at a -65, -85, and -105 dBm signal levels, one after the other. Hitting the "Test" soft key prompts the software to read the received signal level that the phone perceives digitally. A numeric value called the RxDAC (RX D/A converter) is generated within the CDMA ASIC to represent the signal level received. If this number falls within the range of values listed in the Service Software window coinciding with the respective input signal level, the CDMA RX is operating properly. For example, for a -65 dBm input signal should provide an RxDAC value between 480 and 520.

Note: The results of this test will only fall into the ranges stated when the `RX_OFFSET` is properly tuned. With this parameter improperly tuned the resultant values will be slightly different, but still near the stated ranges, provided that the CDMA RX module is functional.

Set Up CDMA RX Test

To troubleshoot the CDMA receiver first remove the shields. Apply power and service cables to the phone and turn it on. Initiate the CDMA RX Troubleshooting Mode from Service Software. Then feed a -65 dBm 881.62 MHz unmodulated CW carrier into the phone via the RF connector at the bottom of the phone. An unmodulated -65 dBm carrier at channel 387 will also work. A stand alone RF signal generator should do the trick, as will a CDMA test box with this functionality. Do not forget to account for the signal loss between the signal generator and the phone.

RX Gain Control Test

A great test to check the health of the CDMA receiver is to monitor the gain control current to the CDAGCR IC. As the CDMA signal strength received by the phone drops, this current increases. Naturally it is difficult and time consuming to break the circuit and position an ammeter in the phone to read this current. A quick way to do so is to simply read the voltage drop across resistor R16. Position one test lead of a volt meter on either side of this resistor and vary the RF input power at 881.62 MHz, unmodulated CW.

The voltage drop across this resistor should resemble the values in the table that follows. Be sure to also check the voltage drop across R17, the `RX_IREF` signal. This drop should be approximately 360 mV.

RF Input Power 881.62 MHz CW (dBm)	Voltage Drop Across R16 (RX_1CT) (mV)
-45	11
-50	14
-55	17
-60	21
-65	25
-70	30
-75	37
-80	45
-85	56
-90	68
-95	83
-100	99
-105	113

DC Voltage Checks

Check the following DC voltages with the -65 dBm 881.62 MHz CW signal still fed into the phone and the Service Software CDMA Troubleshooting Mode initiated.

- The bias voltage on the BFILCT2 IC (N2), pin 4 should be approx **3.10 V**.

If not, first ensure that the phone is in the CDMA Troubleshooting Mode. Check the VBBFIL supply voltage at the collector of V203, or CDCONT (N201), pin 15, or C223. It should be approximately 3.15 V.

- The bias voltage on the BFILCT2 IC (N2), pin 8 should be approx **3.05 V**

If not, first ensure that the phone is in the CDMA Troubleshooting Mode. Check the VRXD_R supply voltage at pin 4 of V206, or CDCONT (N201), pin 15, or C223. It should be approximately 4.50 V.

- The bias voltage on the CDAGCR IC (N1), pin 13 should be approx **4.40 V**.

If not, first ensure that the phone is in the CDMA Troubleshooting Mode. Check the VRXD_R supply voltage at pin 4 of V206, or CDCONT (N201), pin 15, or C223. It should be approximately 4.50 V.

- Measure the voltage drop across R17 at the RX_IREF line, (one probe on either side of this resistor). The voltage drop should be approx **330 mV**.

If not, first ensure that the phone is in the CDMA Troubleshooting Mode. Ensure that the -75 dBm 881.62 MHz CW signal is fed into the receiver. Perform the DC Voltage checks on that module to determine if there is a problem with the AGC circuitry.

- Check the voltage drop across R16 at the RX_ICT line, placing one probe on either side of this resistor. The voltage drop should be approx **37 mV**.

If not, first ensure that the phone is in the CDMA Troubleshooting Mode. Ensure that the -75 dBm 881.62 MHz CW signal is fed into the receiver. If fault is found then continue with the remaining receiver DC Voltage checks. After doing so there is still no problem, refer to the AGC Troubleshooting Manual. Perform the DC Voltage checks on that module to determine if there is a problem with the AGC circuitry.

- Check the CDMA IF LNA V7 and V8

The voltage on the collector of V7, pin 1 should be approximately **1.38 V**.

The voltage on the base of V7, pin 3 should be approximately **1.33 V**.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Inspect V8, V7, L5, R19, R20. Ensure that VRXDM is approximately 4.50 V at R21.

The voltage on the emitter of V7, pin 2 should be approximately .60 V.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Inspect V7, and L6.

- Check the 1st IF gain stage V9

The voltage on the collector, pin 1 should be approximately **3.50 V**.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Inspect V10, V9, R22, R23, Z3. Ensure that VRXDM is approximately 4.50 V at R23

The voltage on the base, pin 3 should be approximately **1.85 V**.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Inspect V9, V4, L13, L11, R4, R5, R13, R14, R15, and R24. Ensure VRXDM is about 4.50 V at R21. See that VRXM is at about 4.40 V at R13, and VRXAM is about 1.15 V at R14

The voltage on the emitter, pins 2 and 4 should be approximately **1.12 V**.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Inspect V9, L14, R25, and R28.

- Check the LNA, V12

The voltage on the collector should be approximately **3.90 V**

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Ensure VRXM is at about 4.40 V at R833. Inspect V11, V12, L20, R33, R34, R38, and R833.

The voltage on the base should be **1.0 V**

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Ensure VRXM is at about 4.40 V at R833. Inspect V11, V12, L21, L22, R33, R35, and R833.

- Check the control voltages on the RF Gain Switches N701 and N702. Pin 1 on both should be approximately **3.80 V**.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Ensure VRXM is at about 4.40 V at R832. Inspect N701, N702, V1, V708, R775, R777, R779, R781, R783, R803, R830, R831, and R832.

- Check the SWAGC line at R830, should be logic level low, approx .0 V.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Ensure VRXM is at about 4.40 V at R832. Inspect V708, R765 and R830. Ohm out line from R765 to the ASIC N704 pin 94.

- Check the RX_CAL line at R783. It should be logic level high, near **2.75 V**.

If not, confirm that the phone is in the CDMA Troubleshooting Mode. Ensure VRXM is at about 4.40 V at R832. Inspect V1, V708, R6, R765, R783, and R785. Ohm out the RX_CAL line from pin 114 of the ASIC N704 to R785.

Chart of CDMA RX DC Node Voltages

The following chart summarizes the node voltages of the CDMA RX when the phone is in the CDMA RX/TX Mode with a 881.62 MHz signal input of -65 dBm, CW.

Node	Voltage (V)
BFILCT2 IC (N2), pin 4	3.10
BFILCT2 IC (N2), pin 8	3.05
CDAGCR IC (N1), pin 13	4.40
R17 – voltage drop across this resistor	0.33
R16 – voltage drop across this resistor	0.037
V7 – collector of CDMA IF LNA, pin 1	1.33
V7 – base of CDMA IF LNA, pin 3	1.38
V7 – emitter of CDMA IF LNA, pins 2, 4	0.60
V9 – collector of 1st IF amp, pin 1	3.50
V9 – base of 1st IF amp, pin 3	1.85
V9 – emitter of 1st IF amp, pins 2, 4	1.12
V12 – collector of LNA	3.90
V12 – base of LNA	1.00
RF Gain Switches N701 and N702. Pin 1	3.80
RF Gain Switches N701 and N702. Pin 8	0.00
SWAGC line at R830	0.00
RX_CAL line at R783	2.75

Baseband Demodulation Check

If you have an oscilloscope available you may use it to do a visual check on the demodulated baseband CDMA I or Q signal. With the phone tuned to channel 384, feed a -75 dBm, 881.62 MHz unmodulated CW RF signal into the receiver. Initiate the CDMA Troubleshooting Mode from Service Software. Use a standard scope probe at C58, the RX_I signal. It should appear as a fuzzy sine wave of approximately 190 mVpp. This frequency will be approximately 100 kHz.

RF Node Powers – CDMA RX Mode

A high impedance passive RF probe may be used with a spectrum analyzer to obtain the RF nodal power levels along the receiver chain. The following levels assume the above probe and a –65 dBm, 881.52 MHz, unmodulated tone input into the receiver. Maintain a 1.0 MHz span on the spectrum analyzer. A CDMA test box with spectrum analyzer capabilities will do.

The RF power levels published below were found with a passive probe with the 500 ohm tip. The blank column is reserved for values the user will obtain with their own probe.

Node	Frequency MHz)	Power Lvl HP10020A 500 ohm tip (dBm)	Power Lvl (your own) (dBm)
CDAGCR IC N1 Pin 19	180	–24	
CDAGCR IC N1 Pin 8	45	–61	
CDMA SAW Output L6/L7/C63	45	–88	
Diode Switch V10 pin 4/L8/L9	45	–57	
1st IF Amp V9 collector, pin 1	45	–57	
1st IF Amp base, pin 3	45	–80	
Mixer T1 pin 4 – IF	45	–80	
Mixer T1 pin 8 – LO	926.52	–19	
Mixer T1 pin 5 – RF	881.52	–75	
RF Switch N701 pin 7 – output	881.52	–75.5	
RF Switch N701 pin 5 – input	881.52	–75.5	
LNA V12 collector	881.52	–68	
LNA V12 base	881.52	–90	
RF Switch N702 pin 7 – output	881.52	–85.5	
RF Switch N702 pin 5 – input	881.52	–85.5	
Duplexor Z102, RX In pin	881.52	–92	
Duplexor Z102, ANT pin	881.52	–89	
Coax W400 – Antenna input	881.52	–87	
Coax W400 – Connector input	881.52	–88	

Hints and Suggestions

AMPS

- **It is important to NOT adjust the tunable inductor L17. Doing so will NOT assist in troubleshooting a faulty receiver, it will only make things worse.** This device is tuned by its manufacturer to the proper inductance.

- While in AMPS Troubleshooting Mode, probe the 455 kHz ceramic filter Z4. A noise pedestal approximately 20 kHz wide will be visible about 10 dBm above the noise floor.

CDMA

- To determine if the CDAGCR IC (N1) quadrature demodulator is functioning, connect both the RX_I and RX_Q to CH1 and CH2 of oscilloscope. Put the scope in X-Y mode. A Lissajous pattern of a circle should be displayed. Changing the received signal power should not cause the size of the circle to change.

Synthesizer Troubleshooting

Introduction

Troubleshooting the synthesizer is difficult because the oscillations that it produces cannot be measured at the output of the phone. The RF signals it generates are routed to various portions of the phone. Assuming the receiver and transmitter are functional, indirect means of determining the health of the synthesizer can be used. Both the transmitter and receiver depend on the synthesizers to operate. If one of the two synthesizers is not working it is most certain that a problem will show up in either the transmitter, receiver, or both. The Service Software RF quick checks are great tools for initial testing. Beyond that there are a few quick DC voltages that can be used to quickly assess the health of the phone. If all else fails, RF node power levels can be read.

Quick Check with Service Software – Transmitter Approach

The fastest way to determine if both synthesizers are working is to turn on the AMPS transmitter. This can be done from Service Software from the AMPS/Baseband test menu. The unmodulated transmit signal can then be viewed with a spectrum analyzer or CDMA test box. This test requires that the AMPS transmitter be functional. If the transmitter is faulty the receiver may also be used as a means to test the synthesizer.

To set up this test, connect the RF output of the phone to a spectrum analyzer or CDMA test box using the bottom connector. If the CDMA test box is used it is best to make use of the spectrum analyzer function if the box used has one. If not, the AMPS TX test functions will work. Configure the analyzer as such:

Center Frequency:	836.52 MHz (Channel 384)
Span:	20 MHz
Ref Level:	30 dBm

Turn on the AMPS transmitter from Service Software, setting the power level to the lowest setting, level 7. Tune to channel 384. Initiating the AMPS Troubleshooting mode also turns on the AMPS transmitter to channel 384. Look at the AMPS transmit signal on the spectrum analyzer.

- If the signal is a strong (greater than -10 dBm) CW carrier locked to 836.52 MHz then both synthesizers are working properly. Change the span of the analyzer to 100 kHz and ensure that the carrier is on frequency to within 100 Hz.
- If a signal comes up but is slightly off frequency then the reference clock, the VCTCXO (G300) is mistuned. Proceed to the section titled Testing and Troubleshooting for Frequency Error.

- If the signal comes up, but is very much off frequency (more than a few kHz) or is drifting around then the one or both of the PLLs is not locked. Proceed to the section titled Testing and Troubleshooting for Synthesizer Lock Error.
- If no signal is seen then it is possible that the transmitter is not working. If the noise floor rose when you initiated the test, then it is likely that the transmitter is working, but it has no signal to amplify. This would indicate a faulty synthesizer. To rule out synthesizer error, proceed to the next Service Software synthesizer test, the Receiver Approach. Performing the DC Voltage Checks would also be advised.

Quick Check with Service Software – Receiver Approach

Another way to determine if both synthesizers are working is to test the AMPS and CDMA receiver with a signal fed in. This can be done from Service Software. Perform the CDMA RX RF Quick Test followed by the AMPS RX RF Quick Test. These tests are found in the Service Software Test menu.

- If the phone passes the CDMA RX RF Quick Test then both synthesizers are working
- If the phone fails the CDMA RX RF Quick Test, but passes the AMPS RX RF Quick Test, then the 180 MHz VHF synthesizer has failed, assuming both the AMPS and CDMA receivers work. Proceed to the DC Voltage Checks, VHF Synthesizer portion
- If the phone fails both RX RF Quick Tests then proceed to the DC Voltage checks section.

DC Voltage Checks – AMPS Troubleshooting Mode

Put the phone into AMPS Troubleshooting Mode. This will turn both of the synthesizers on. The following details the node voltages for the VCTCXO, PLL IC, VHF and UHF portions of the synthesizer. Note that these node voltages will change slightly when the phone is operating in CDMA mode.

VCTCXO (G300)

- Check the bias on pin 4. It should be near **3.60 V**.
If not, check R325, C303, and C334. Check VRXS at C207 near the CDCONT IC. It should be approximately **4.40 V**

- Check the tune voltage on pin 1. It should be between **1.50** and **2.50 V**.

If not, check R302, R301, and C302. Check the RX_SLOPE and AFC PDM lines. Manually adjust them with the PDM controls within Service Software. Read the RX_SLOPE PDM voltage at R700 and read the AFC PDM voltage at R701. While tuned to channel 384 the RX_SLOPE PDM should be about 3.00 V. For channel 440 it should be 0.0 V. The AFC PDM will vary between 0.0 V and 3.00 V, generally near the midrange of 1.50 V.

PLL IC (N301)

- Check the biasing on the PLL IC (N301). Pins 4 and 5 should have approximately **3.15 V** on them. Pin 18 should have about **4.40 V**. Check pin 19, AON, it should have about **2.80 V**.

If not, check VRXS at C207 near the CDCONT IC. It should be approximately **4.40 V**. Check the pin 14, Iset, for 1.25 V. Check VRX90 at C205 or R310. It should also be approximately **4.40 V**. Check R331, R307, R308, R310, R311, R807, R810 and C337.

VHF Synthesizer

- Check the tune voltage at the cathode of V301. It should be stable at a single voltage between **1.50** and **3.5 V**.

If not, check to see that the 180 MHz oscillation is feeding back into the PLL IC at pin 15. Continue with the following two checks. Ensure that the varactor diode, V301 is in the circuit correctly.

- Check the biasing of the buffer amp, V303.

The collector should be biased with **4.30 V**.

The base should be biased with **3.30 V**.

The emitter should be biased with **2.60 V**.

If not, check VRX90 at R806 or at C205 near the CDCONT IC. It should be approximately **4.40 V**. Inspect L303, R316, R318, R322, R323, R324, and R806. Also inspect C319, C321, C322, C323, C324, C328, C329, C330, C332, C333, and C340.

- Check the biasing on the oscillator transistor, V302.

The collector should be biased with **2.60 V**.

The base should be biased with **2.30 V**.

The emitter should be biased with **1.73 V**.

If not, check VRX90 at R806 or at C205 near the CDCONT IC. It should be approximately **4.40 V**. Inspect L303, R316, R318, R322, R323, R324, and R806. Also inspect C319, C321, C322, C323, C324, C328, C329, C330, C332, C333, and C340.

4.3.2.4 UHF Synthesizer

- Check the biasing on the UHF VCO, G301. There should be approximately **4.25 V** at pin B.

If not, check R808. Check to see that VRXS is **4.40 V** at C207.

- Check the tune voltage at pin C. It should fall in the range of 1.5 to 3.5 V.
If not, check the PLL IC. Ensure that the RF feedback is correct into the PLL at pin 6.
- The RX_LO gain stage N704, pin 3 should be about **3.40 V**.
If not, check R803 and see that VRX is **4.40 V** at C206.
- The TX_LO gain stage N705, pin 3 should be about **2.70 V**
If not, check R809 and R815. Ensure that VTX is approximately **4.40 V** at R809 or C212.

Chart of Synth DC Node Voltages – AMPS Troubleshooting Mode

Node	Voltage (approx) (V)
G300 – VCTCXO bias, pin4	3.60
G300 – VCTCXO Tune voltage, pin 1	1.50 – 3.50
N301 – PLL IC bias, pins 4, 5	3.15
N301 – PLL IC bias, pin 18	4.15
N301 – PLL IC bias, pin 19	2.80
V301 – Varactor diode – 180 MHz tune voltage	1.50 – 3.50
V303 – VHF Buffer Amp – Collector	4.30
V303 – VHF Buffer Amp – Base	3.30
V303 – VHF Buffer Amp – Emitter	2.60
V302 – VHF Oscillator – Collector	2.60
V302 – VHF Oscillator – Base	2.30
V302 – VHF Oscillator – Emitter	1.73
G301 – UHF VCO bias, pin B	4.00
N704 – UHF RX_LO gain stage	3.40
N705 – UHF TX_LO gain stage	2.70

RF Node Power Levels

A high impedance passive RF probe may be used with a spectrum analyzer to obtain the RF nodal power levels for the synthesizer circuit. The following levels assume the above probe. The phone was also operating in the AMPS Troubleshooting Mode via Service Software. The blank column is reserved for values the user will obtain with his or her own probe.

Node	Frequency (MHz)	Power Lvl HP10020A 500 ohm tip (dBm)	Power Lvl (your own) (dBm)
G300 – VCTCXO, pin 1	15.36	–15.0	
V303 – VHF Buffer Amp – Collector	180	–24.0	
V303 – VHF Buffer Amp – Emitter	180	–30.0	
V302 – VHF Oscillator – Collector	180	–30.0	
G301 – UHF VCO, pin P	926.52	–30.0	
N704 – UHF RX_LO gain stage	926.52	–20.0	
N705 – UHF TX_LO gain stage	926.52	–40.0	

Hints and Suggestions

- If no spectrum analyzer is available, a lot can be learned about the health of a PLL by checking the control voltage tuning the VCO. If the PLL is locked, this control, or tune voltage will fall between 1.5 and 3.5 V DC. If the control voltage is near 0.0 or 4.4 V, the loop is most likely unlocked.
- Probing the cathode of the varactor diode, V301 may unlock the VHF loop.
- Modulation cannot be seen on the anode of the varactor when using an oscilloscope. The level is too low. Instead, measure it at R317/C341 node.
- To check to see that the PLL IC (N300) is programmed by the CDSB ASIC (D704), probe the CLK, DATA and RX_LE lines with an oscilloscope. Monitor the oscilloscope when the channel is changed. Use the Service Software test functions to change the channel. When the channel is changed the PLL IC is reprogrammed. The RX_LE line will provide 5 evenly spaced pulses. The CLK signal will be a square wave, 0.0 to 3.0 V, and the DATA line will show a stream of pulses, with no discernible pattern.
- To check the functionality of a VCO, apply an external DC supply to the control voltage pin, like the C pin of G301. The output frequency of the VCO will change when the control voltage is varied.

AGC Troubleshooting

Introduction

Detailed below are a number of tests designed to demonstrate the functionality of the features and systems described above in the Functional Description. All make use of the control abilities of the Service Software, all located in the Testing menu of the software package. AMPS feature testing is mainly performed from the AMPS/Baseband test suite. CDMA feature testing makes use of a menu of CDMA system controls. The two most useful features of the latter group are the CDMA TX Manual Gain controls and the CDMA RX Manual Gain controls. The PDM controls are also used extensively throughout the testing procedures.

DC Supply Checks

The voltage supplies used to bias the RF module is detailed below. The following table details the voltage of each supply when the phone is in either AMPS or CDMA mode. Shaded boxes indicate that a supply is active.

- AMPS RX/TX mode can be achieved by initiating the AMPS Troubleshooting Mode from the Services Software.
- CDMA RX/TX mode can be achieved by initiating the CDMA Troubleshooting Mode from the Services Software.

	VBBFIL	VNEG	VRX	VRXA	VRXD	VRXD_R	VRXS	VRX90	VTX	VTXS
Measurement point	C224	N200 pin 5	C206	C219	C218	N706 pin 4	C207	C205	C212	C200
AMPS RX/TX	~ 0.0	-4.10	4.45	4.45	1.65	~ 0.0	4.45	4.45	5.30	4.45
CDMA RX/TX	3.15	-4.10	4.45	1.20	4.45	4.50	4.45	4.45	5.35	4.45

CDMA TX Gain Limiting Test

To test the CDMA TX Gain Limiting control, perform the following steps:

- Place the phone in the CDMA Troubleshooting Mode.
- With an oscilloscope probe the LIM_ADJ line at C807.
- Adjust the gain of the CDMA transmitter to maximum output power using the CDMA TX manual gain control mechanism found in the Service Software.
- The LIM_ADJ line will remain at about 3.2 VDC until the TX output power reaches its limit, approximately 24 dBm. At this point the LIM_ADJ line should toggle continuously, appearing as a square wave 3.2 Vpp with an approximate frequency of 400 Hz.

Dynamic TXB Test

To test the Dynamic TXB functionality, perform the following steps:

- Place the phone in the CDMA Troubleshooting Mode.
- Use the Service Software CDMA TX manual gain controls to achieve 10 dBm CDMA TX output power.
- Read the total current draw of the phone. It should be approximately 530 mA.
- Increase the CDMA TX output power to 23 dBm. The current draw should rise to approximately 690 mA.

Note that the difference is about 150 mA, which is the difference between the two current biasing levels.

	CDMA TX 10 dBm (mA)	CDMA TX 23 dBm (mA)	AMPS Power Level 7 (mA)	AMPS Power Level 2 (mA)
2180 Current Draw	530	690	400	610

CDAGCT IC (N100) Gain Control Test

To test the gain control abilities of the CDAGCT IC (N100) perform the following steps:

5. Place the phone in the CDMA Troubleshooting Mode
6. Observe the TX output with a spectrum analyzer or CDMA test set. Be sure to read bandpower over a 1.23 MHz band.
7. Use the CDMA TX manual gain control found in the Service Software to adjust the output power from its minimum (noise floor) to 15 dBm.
8. Observe the TX_Gain voltage at C226 and the TX_ICT current as a voltage drop across R116. The table below details approximate values that should be read.

CDMA TX Output RF Signal Level (dBm)	TX_GAIN + TX_OFFSET Voltage at C226 (V)	TX_ICT Control Current (mA)	TX_ICT (as voltage drop across R116) (mV)
15	1.78	0.700	70.0
10	1.80	0.560	56.0
-5	1.87	0.298	29.8
-20	1.93	0.171	17.1
-35	2.00	0.093	9.3

Auxiliary AGC Test

To test the gain control abilities of the Auxiliary AGC feature, perform the following steps:

1. Place the phone in the CDMA Troubleshooting Mode
2. Observe the TX output with a spectrum analyzer or CDMA test set. Be sure to read bandpower over a 1.23 MHz band.
3. Use the CDMA TX manual gain control found in the Service Software to adjust the output power of the phone from 15 dBm to 23 dBm.
4. Observe the VC voltage at C109 and the AGC_REF PDM voltage at C716. The table below details approximate values that should be read.

CDMA TX Output Power (dBm)	AGC_REF PDM (decimal value)	AGC_REF PDM voltage at C716 (V)	VC at C109 (V)
23	0	0.798	3.28
21	34	0.583	2.81
19	60	0.456	2.53
17	79	0.367	2.33
15	85	0.333	2.26

For CDMA TX operation above the switchpoint, the TX_ICT current will be at its maximum, approximately 1.0 mA. There should be approximately 100 mV of voltage drop across R116.

For more information on the Auxiliary AGC control feature, consult section 3.4.3.2 of this document.

CDMA RX Gain Control Test

To test the gain control abilities of the CDAGCR IC (N1) do the following:

3. Place the phone in the CDMA Troubleshooting Mode
4. Use the CDMA RX manual gain control found in the Service Software to adjust the CDMA receiver gain.
5. Verify the RX_IREF current signal as the voltage drop across R17. The voltage drop should be approximately 350 mV.
6. Observe the RX_Gain voltage at C213 and the RX_ICT current as a voltage drop across R16. The table below details approximate values that should be read.

CDMA RX RF Signal Level (dBm)	RX_GAIN Voltage at C213 (V)	RX_ICT Control Current (mA)	RX_ICT (as voltage drop across R16) (mV)
-25	2.06	0.020	7
-45	2.00	0.033	11
-65	1.91	0.073	24
-85	1.82	0.158	52
-105	1.73	0.278	92

AMPS TX Gain Control Test

The AMPS transmitter gain is controlled from the TXI_REF PDM. This PDM has a manual control within the AMPS Quick Checks window of the Service Software Test menu. With the phone in AMPS Troubleshooting Mode the transmitter output power can be manipulated with this PDM control. The table below details approximate PDM values, in decimal, necessary to achieve corresponding power levels. These values will vary from phone to phone.

AMPS TX Output Power (dBm)	TXI_REF PDM decimal value
30	00
27	238
24	208
21	176
18	166
15	160
12	155
9	152
6	151

Note the PDM decimal values are not linearly related. Therefore the maximum value of 255 roles over to the minimum value of 0 at the midpoint of the scale. This explains the significant difference between the PDM decimal values of 27 dBm to 30 dBm.

CDMA AGC Loop Test

This procedure tests the ability of the CDMA transmitter output power to track the CDMA receiver input power. This requires a configuration of the test equipment that allows the ability to view the transmitter output power while varying the input receive power. However, for this test it is not so important to know the absolute output power of transmitter, but rather to see the change in output as a function of the change in input. Configure either of these devices as such:

Spectrum Analyzer (Measures output of TX)

Frequency: 836.52 MHz

Span: 2 MHz

Amplitude: 30 dB

Signal Generator (Injects signal into RX)

Frequency: 881.62 MHz

Modulation: None (CW signal)

Perform the test as such:

2. Calibrate any cable loss between the phone and the test box.
3. Set the input signal amplitude to -65 dBm
4. Read the bandpower of the output CDMA signal. It should be approximately -8 dBm.
5. Decrease the input signal amplitude to -85 dBm.
6. Read the bandpower of the output CDMA signal. It should be approximately 12 dBm, a 20 dB shift from the previous state.

Note: This test assumes that the phone is properly tuned. If it is not, the 20 dB change in input signal strength may not correspond to a 20 dB change in TX output. If bandpower cannot be read, then simply look at the 1.23 MHz wide CDMA signal with the spectrum analyzer. The peak will increase about 20 dB with a 20 dB decrease in the receiver input.

Another method to perform this test would be to make use of a spectrum analyzer and signal generator as separates. In this case a circulator used to isolate the input and output signals of the phone from the signal generator and spectrum analyzer respectively. Be sure to calibrate out the cable and circulator losses.

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